DOCTOR OF PHILOSOPHY

‘Agricultural policy change and the sustainability of farming in the uplands’

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Award date:
2021

Awarding institution:
Bangor University

‘Agricultural policy change and the sustainability of farming in the uplands’

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April (2021)

A thesis submitted to Bangor University

in candidature for the degree Philosophiae Doctor

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Thesis Summary

A UK exit from the European Union (EU) means the UK agricultural sector is facing the most significant changes to policy since joining the European Economic Community (EEC) and the Common Agricultural Policy (CAP) in 1973. These changes will predominantly impact upon upland livestock farmers currently heavily reliant on direct subsidies. In future, farmers wishing to access public money, will have to deliver the 'public goods' needed to enable the government to reach biodiversity and net-zero carbon emission targets. This thesis focuses on agricultural policy change and the sustainability of farming in the uplands concentrating on the social, human and natural capital aspects of adapting to change.

First, CAP payments data was used to assess Pillar 1 payments structure and distribution and explore the potential impact that subsidy removal may have on land use in Wales. This approach enabled me to present a comprehensive picture of farm holdings, land areas and livestock numbers at risk from direct subsidy removal. It shows livestock farmers in Less Favoured Areas (LFA) being the most vulnerable to changes in CAP payment structure.

Overlay and geoprocessing techniques in Geographic Information Systems (GIS), and an analysis of the Welsh Glastir agri-environment schemes (AES) were used to explore Pillar 2 payment structures and AES design and structure to identify strengths and weakness in the system. An analysis of option uptake for the Glastir Advanced and Entry level schemes found a few options, which fitted the current farming system, to have the highest uptake levels. This means that in upland areas where Glastir uptake is highest, there is little or no change to farming practice. I concluded that whilst AES helps maintain the *status quo*, they do little to contribute to improving biodiversity and reducing carbon emissions. Similarly, through a qualitative study into the barriers to the uptake of the English Countryside Stewardship Scheme (CSS), I found

high transaction costs and poor 'goodness of fit' to current farming practice, forcing farmers to leave AES. One solution identified was to lower transaction costs and improve relationships between the scheme provider and deliverer through the decentralisation of AES policy.

A survey was used to identify farmer attitudes to subsidies and policy change. It found most farmers thinking the current subsidy system is unfair and that it should change, but it also showed that many, especially upland livestock farmers, stating they could not survive without direct payments. Policy makers will need the cooperation of farmers and landowners if they are to implement the level of public goods delivery required to reach Net Zero carbon by 2050. To explore how networks and access to social capital hinders or helps in adapting to change, I conducted a social capital analysis of farmers in and out of AES, and with farmers delivering high nature value farming objectives above and beyond that required of state-run AES. I found production-focused farmers not in AES, and many in AES, having high levels of bonding social capital. These groups were inward looking and mistrusting of anyone outside of the immediate network. Farmers in the high nature value group had higher levels of bridging and linking capital and wider networks and were more trusting. I concluded that this group is more adaptable to change and more likely to remain viable post-policy change.

Finally, carbon footprinting and case studies were used to explore how upland farmers might adapt to policy change and remain socially, economically and environmentally sustainable. This research provides a detailed understanding of the impact of policy change and the complexities surrounding the farmers' ability to adapt to change and deliver policy targets. Farming practice will have to change, and the shape and nature of farming in the uplands is likely to be significantly different after a EU departure. However, results suggest that upland farmers can help deliver net zero carbon emissions and other similar sustainability targets through a move to more extensive farming practices and a reduction in overall livestock numbers.

Thesis Content

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Acknowledgements

My journey to this point started approx. seven years ago when I met with Prysor Williams to discuss my forthcoming arrival in Bangor to study Agriculture, Conservation and the Environment. Confident, but a little apprehensive at re-entering the education system after thirty-five years, I was quickly put at ease and reassured that my journey would be an enjoyable one. I would like to thank Prysor and all the lecturers on that course for their professionalism, their knowledge and experience, and for fuelling a new passion within me that has left me with a thirst for more knowledge.

For believing in me and for giving me the opportunity to development my research ideas, I would like to thank my supervisors Davey Jones and Dave Chadwick who have challenged and encouraged me as I travelled along this pathway. I would also like to thank Sophie Wynne-Jones and Norman Dandy for their support and advice on the qualitative aspects of this project and Ian Harris for his knowledge and support as I developed my GIS skills.

Thanks go to Helen Keep at the Yorkshire Dales National Park and Mark Hughes at the Henfaes Research Centre for their help in identifying farmers to participate in my study and to all the farmers who gave up their time to talk with me. A special thanks goes out to the conservation team at the North York Moors National Park, especially Rebecca Thompson, who welcomed me into their team, gave me support and encouragement, and opened my eyes to the beauty of the North York Moors and the people who live within the national park.

Lastly, thanks to my family and my friends for encouraging and constantly reminding me I could do this. An extra special thanks goes to my wife for believing in me and for looking after our home and pets as I made the often, weekly trips to Bangor.

Abbreviations

AES – Agri-environment scheme

AFOLU – Agriculture, Forestry and Other Land Use

AHDB – Agriculture and Horticulture Development Board

ALC – Agricultural Land Classification

ASO – Agricultural Statistics Office

BBC – British Broadcasting Corporation

BFP – Basic Farm Payment

BPP – Beneficiary Pays Principle

BPS – Basic Payment Scheme

C – Carbon

CAP – Common Agricultural Policy

CCC – Committee for Climate Change

CCS – Carbon Capture and Storage

CDO – Commons Development Officer

CEH – Centre for Ecology and Hydrology

CH_4 - Methane

CLM – Cumulative Link Models

CO_2 – Carbon Dioxide

CPH – County Parish Holding

CS – Case Study

CSS – Countryside Stewardship Scheme

DA – Disadvantaged Area

DAERA – Department of Agriculture, Environment and Rural Affairs

DBEIS – Department for Business, Energy and Industrial Strategy

DEFRA – Department for Environment, Food and Rural Affairs

DfID – Department for International Development

EC – European Commission

EAFRD – European Agricultural Fund for Rural Development

EAGF – European Agricultural Guarantee Fund

EEA – European Environment Agency

EEC – European Economic Community

ELMS – Environmental Land Management Scheme

ESS – Environmental Stewardship Scheme

EU – European Union

FAO - Food and Agriculture Organization

FBI – Farm Business Income

FBS – Farm Business Survey

FCL - Foundation for Common Land

FLEXIS – Flexible Integrated Energy Systems

GA – Glastir Advanced

GBP – Great British Pound

GE – Glastir Entry

GC – Glastir Commons

GHG – Greenhouse Gas/Gases

GIS – Geographic Information System

GO – Glastir Organic

GSG – Glastir Small Grants

GWC – Glastir Woodland Creation

GWR – Glastir Woodland Restoration

HNVF – High Nature Value Farming

IPCC – Intergovernmental Panel on Climate Change

LCA – Lifecycle Assessment

LCM – Land Cover Map

LFA – Less Favoured Area

LPIS – Land Parcel Identification System

LSU – Livestock Unit

LULUCF – Land Use, Land Use Change and Forestry

LWT - Liveweight

MBI – Market Based Instruments

NFU – National Farmers Union

NGO – Non-Governmental Organisation

NPA – National Parks Authority

NRW – Natural Resources Wales

NYMNP – North York Moors National Park

NYMFS – North York Moors Farm Scheme

NYMNPA – North York Moors National Park Authority

NW – North Wales

OS – Ordnance Survey

PALC – Provisional Agricultural Land Classification

PBR – Payments by Results

PES – Payments for Ecosystem Services

PONT - Pori, Natur a Threftadaeth

REDD - Reduced Emissions from Deforestation and Forest Degradation

RPA – Rural Payments Agency

RPW – Rural Payments Wales

RSPB – Royal Society for the Protection of Birds

SDA - Severely disadvantaged area

SE – South East

SGRPID - Scottish Government Rural Payments and Inspections Directorate

SLM/S – Sustainable Land Management/Scheme

SO – Standard Output

SW – South West

TC – Transaction Costs

TCE - Transaction Cost Economics

TEEB - The Economics of Ecosystems and Biodiversity

UAA – Utilised Agricultural Area

UK – United Kingdom

UKNEA – United Kingdom National Ecosystem Assessment

UN – United Nations

UNEA – United Nations Environment Agency

US – United States

WEFO – Welsh European Funding Office

WFC – Whole Farm Code

WG – Welsh Government

WRO – Welsh Rural Observatory

WTO – World Trade Organisation

WSO – Welsh Statistics Office

YDNP – Yorkshire Dales National Park

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Chapter 1

Introduction

Sustainable agriculture in the uplands: The challenges and the need for research

1.1. Sustainable agriculture in the uplands: The challenges and the need for research

The growth of science and the social activities of humankind have significantly increased since the onset of the industrial revolution, transforming the earth's biosphere and advancing the decline of earth's ecosystems (Ruddiman and Thomson, 2001; Oldfield and Shaw, 2006; Raupach and Canadell, 2010; Zalasiewicz et al., 2010; Steffen et al., 2011; Ellis et al, 2013; Malhi et al., 2020). Development (new and upgraded roads, railways or ports, energy generation and transmission, and extractive industries; Jones et al., 2019), agriculture and industrial livestock farming (Kraham, S.J., 2017), deforestation (Vijay et al., 2016) and climate change (Nunez et al., 2019) are impacting upon the environment, and speeding up the loss of biodiversity. Greenhouse gas (GHG) release is cited as being the most common contributory factor to climate change and a rise in global temperatures, with the most abundant of these GHGs being, carbon dioxide (CO_2) from fossil fuel use, deforestation and land use change, methane (CH_4) from enteric fermentation, manure management, land use change and rice paddies, and nitrous oxide (N_2O) from fertiliser use in agriculture (IPCC, 2013; de Vries et al., 2016; Xi-Liu and Qing-Xian, 2018).

These anthropogenic impacts are further exacerbated by the growth of the world's population which, in 2015, amounted to approximately 7.3 billion people and is projected to rise by about a billion within the next 20 years, reaching 8.5 billion in 2030, 9.7 billion in 2050, and 11.2 billion in 2100. (UN, 2017). This growth will, according to experts, require an increase in food supply at least by 50% and in some forecasts up to 100% (Godfray et al., 2010; Herrero and Thornton, 2013; Verburg et al., 2013). Furthermore, it is estimated that by 2050, the environmental impacts of food production are also expected to further increase by 50–90% (Springmann et al. 2018). Governments across the globe are potentially facing crisis given that climate change, including increases in frequency and intensity of extremes, has already adversely impacted food security and terrestrial ecosystems as well as contributed to desertification and land degradation in many regions (IPCC, 2019). Proposed mitigation scenarios suggest combining strategies such as sustainable intensification, organic agriculture, changing diets and reducing food wastes in a bid to meet the climate change, biodiversity loss and food security challenges (Godfray and Garnett 2014; Aleksandrowicz et al., 2016; Muller et al., 2017; CCC, 2019; Ganivet, E., 2020). Environmental sustainability, used as a key mitigation strategy, is being implemented against the backdrop of human population growth and the rampant exploitation of environment by humans (Arora, 2018). It is a major driver of change in environmental, agricultural and climate change policy as governments strive to tackle this existential climate change and environmental crisis (Goldsmith, 2020).

The UK government has responded to climate change challenges by signing an agreement making it the first major economy in the world to pass laws to end its contribution to global warming by 2050 (UK Government, 2019a, NAO, 2020). The Committee for Climate Change (CCC) conclude that net zero is necessary, feasible and cost-effective (CCC, 2019). However, the Net Zero Review (NAO, 2020) finds the government is yet to put in place all the essential components for effective cross-government working, such as integrated planning and progress monitoring, and processes to manage interdependencies, to ensure all of government steps up to this challenge. If these problems can be overcome, the CCC estimate that Scotland can have net-zero GHG emissions by 2045 and England by 2050, but as Wales has less opportunity for CO_2 storage and relatively high agricultural emissions that are hard to reduce, they estimate that on current understanding, it could not credibly reach net-zero GHGs by 2050. Wales should therefore set a target for a 95% reduction in emissions by 2050 relative to 1990 (CCC, 2019). Land is simultaneously a source and a sink of CO_2 due to both anthropogenic and natural drivers, but when sustainable land management practices, including sustainable forest management, are implemented they can prevent and reduce land degradation, maintain land productivity, and sometimes reverse the adverse impacts of climate change on land degradation

(IPCC, 2019). In order to reach net zero GHG emissions, scenarios recommend changes to farming practice and land use to put much more emphasis on carbon sequestration and biomass production CCC (2019). A three-way approach would see an increase in healthier diets, reductions in food waste, and a fifth of UK agricultural land shifting to tree planting, energy crops and peatland restoration. This approach to delivering net zero GHG emissions is being supported with changes to agricultural policy which are likely to significantly impact on the way farmers and landowners work and manage the land.

Agricultural policy has always been a key driver of land-use change (Robinson and Sutherland, 2002; Mattison and Norris, 2005; Boatman et al., 2007). Immediately following the Second World War, UK agricultural policy was firmly set on meeting the domestic food needs at a reasonable price, with fair rewards to farmers and agricultural workers (Bowers, 1985; Hubacek et al., 2009). This continued when the UK joined the Common Agricultural Policy (CAP) where production-focussed agricultural support schemes such as guaranteed prices and farm capital grants provided incentives to farmers for increased output through improved grassland management and increased stocking rates (Boatman et al., 2007; Hubacek et al., 2009). These policies clearly impacted upon habitat structure and sward height grassland composition (Boatman et al., 2007) and in turn negatively impacted upon biodiversity and water quality (Donald et al, 2002; McCracken, 2011). CAP reforms in the late 1990's and early 2000's decoupled payments from production, introduced cross-compliance with a variety of EU environmental, animal welfare and food safety standards, and implemented a mandatory green payment for farmers who follow a number of practices beneficial to the environment and climate. (Matthews, 2013; Sinabell and Schmid, 2016). Despite these attempts to 'green' the CAP, greening measures have led to only small changes in management practices and as a result, their environmental and climate impacts have been limited, making only a small contribution towards promoting more sustainable farming practices and have had little or no impact on GHG emission abatement (Solazzo et al., 2016; Hart et al., 2017). In addition, agri-environment schemes (AES), introduced during the 1990 reforms to compensate farmers for loss of income associated with measures to benefit the environment or biodiversity, have been found to have limited or no impact on biodiversity (e.g., birds, plants, butterflies etc) and water quality (Kleijn et al., 2001; Kleijn et al, 2006; Daskalova et al., 2019; MacDonald et al., 2019).

The UK's withdrawal from the EU will have wide-reaching consequences for the UK food and agricultural sector, arguably more than any other sector (Benton et al., 2019). The CAP, which influences what and how food is grown, and determines the structure and amount of financial support payments (Benton et al., 2019), will no longer be in force in the UK. England, and the devolved nations will have independent agricultural policies, but they will all drive land use change through a restructuring of the payments system (UK Government, 2020). Direct payments, currently made to farmers under Pillar 1 of the CAP, will be phased out and will be replaced with a system which pays public money for public goods (Defra, 2018). Current proposals are to replace the current payments system with an environmental land management scheme in England (ELMS; Defra, 2018) and a sustainable land management scheme in Wales (SLMS; WG, 2019). Scotland and Northern Ireland have both completed the consultation process with stakeholders and have entered a transition phase, but at the time of writing a vision for agricultural policy post-Brexit is unclear.

Climate change and agricultural policy and the Environment Bill 2020 (Defra, 2020) which sets targets across four priority areas (air quality, biodiversity, water, and resource efficiency and waste reduction), are intrinsically linked through a mutual objective, namely environmental sustainability. However, their implementation will undoubtedly impact on all three pillars of sustainability, especially in the upland grazing livestock sector (Fig. 1.1[1]). In England and

[1] Adapted from an image by redalpi.com.

Wales there is a plan to ensure that farmers have options to change farming practice and therefore receive payments (Defra, 2018; WG, 2019), but there are concerns that without direct support payments upland grazing livestock farmers will struggle to survive. This is especially true if payments for public goods are not at a similar payment's scales to current direct payments, or if trade tariffs are applied (Wallace and Scott, 2017; Dwyer, 2018; Hubbard et al., 2018; Liddon et al., 2019).

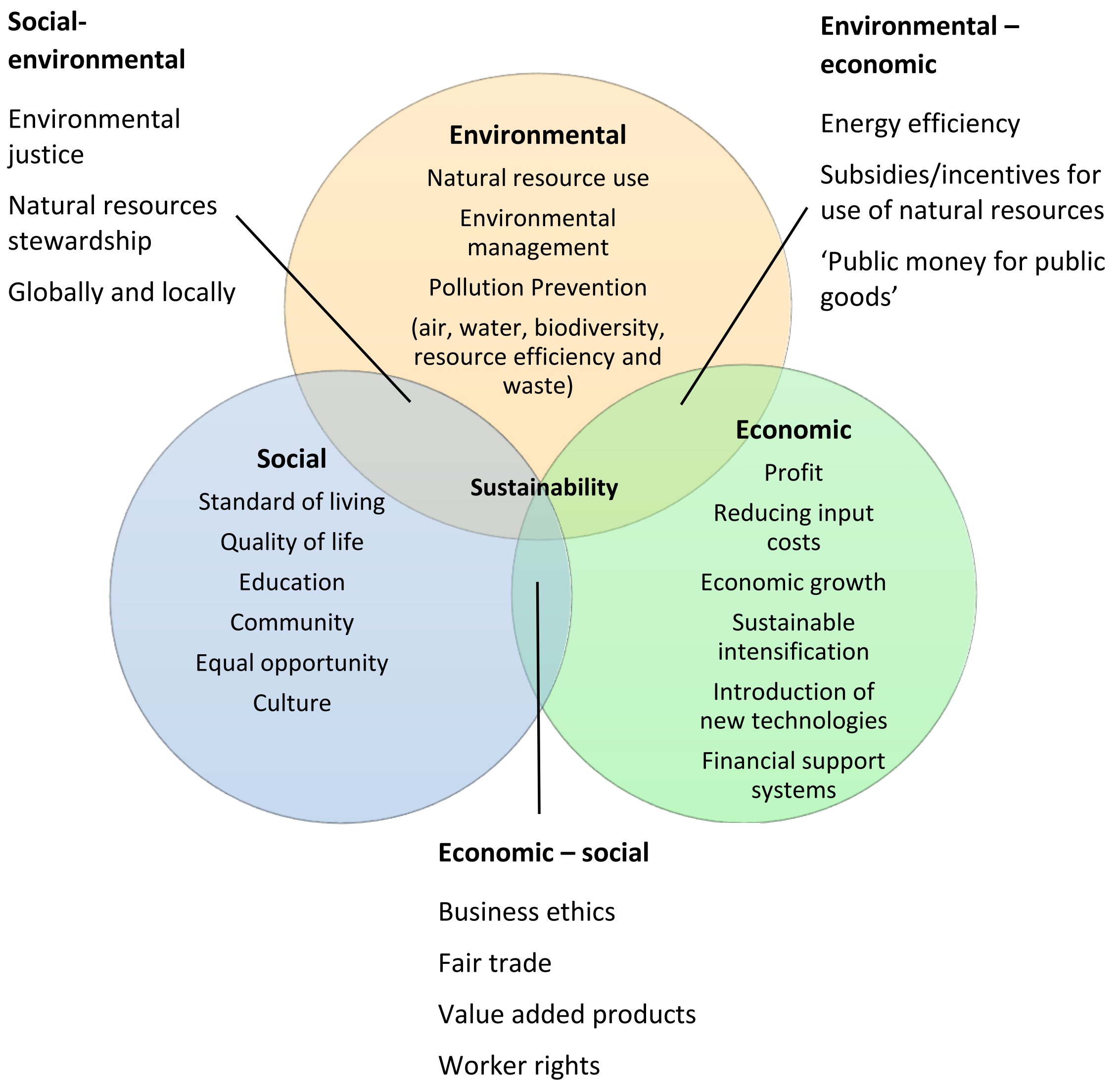

Figure 1.1. The environmental, social and economic pillars of sustainability applied to the farming sector.

In 2002, the 'Curry Report' (Curry et al., 2002) clearly identified that farming, in England, was unsustainable stating that long term direct subsidies, were part of the problem, not the solution, dividing producers from their market, distorting price signals, and masking inefficiency. The report suggests that to survive in a world without direct production subsidies, farmers would need to employ a combination of three strategies: driving out unnecessary cost; adding value; or diversifying the business (Curry et al., 2002). The process of social, political and environmental change expressed in the developing policy landscape has highlighted for farmers, especially upland grazing livestock farmers, the difficulties of persisting with traditional 'productivist' business models (Morris et al., 2017), therefore change is inevitable. Farming in the uplands presents a number of challenges; they are physically remote from the rest of the country; they face harsher climates and poorer soils conditions than other areas; they are economically remote and tend to be hard places from which to make a living; and opportunities to diversify land use are narrow (Reed et al., 2009: Hardaker, 2018; Mansfield, 2019a).

Despite these challenges, it is widely recognised that the upland habitats of the UK contribute vastly to the delivery of ecosystem services which benefit the health and well-being of the population and contribute towards environmental targets (UK Parliament, 2010; UK National Ecosystem Assessment, 2011; Mansfield, 2017; Mansfield, 2018). However, despite improvements in some areas, many ecosystem services continue to decline or have shown little improvement (UK National Ecosystem Assessment, 2011) and many have yet to be economically valued to allow their relative contributions to be assessed (Mansfield, 2018). The approach taken by ELMS (Defra, 2018) and the SLMS (WG, 2019) aims to link the three pillars of sustainability by providing economic benefits to farmers if they deliver positive environmental and social outcomes alongside food production. Whilst this approach may present some farmers and land managers with an opportunity to secure farm viability, especially if they reduce input costs, diversify the business and change farming practice, as suggested in the ‘Curry Report’ (Curry et al., 2002), it is likely that some farms will not be viable post-policy change (Dwyer, 2018; Barnes et al., 2020).

The UK uplands may be ideally suited to a ‘public money for public goods’ approach to land management, but they are so much more than agriculture and natural resources. They are a complex mix of social, human and natural capitals all interdependent of the other (Mansfield, 2018; Mansfield, 2019a).

- Physical capital – physical structures, buildings or land that a person has at their disposal
- Human capital – the knowledge and skills individuals bring to a situation
- Financial capital – money to put into a venture from a variety of sources
- Social capital – the ‘glue that holds society together’
- Cultural capital – tangible and intangible features created by the interaction of people with their environment.

The uplands are iconic landscapes of exceptional scenic beauty, often characterised by distinctive cultural identities related to traditional land use activities (Whyte, 2007; Reed et al., 2009; Mansfield, 2015; Tanulku, 2019). Local buildings and dry-stone walls, and land uses such as hay meadows and common grazing, can represent a rich cultural heritage that is also sympathetic to the natural landscape and resources. In landscape terms, this sustains a strong sense of place and identity for both local people and visitors (Burton et al., 2006; Reed et al., 2009: Mansfield, 2019b). Furthermore, UK uplands have inspired generations of writers, poets and artists, as well as providing cognitive and educational stimuli as dynamic, living landscapes (Reed et al., 2009, Burton, 2018). Iconic landscapes seen in our national parks and protected areas are often thought of as ‘natural’ habitats however, they are largely anthropogenic in character shaped by past management systems – to produce fuel, as much as food (Burton et al., 2006; Williamson, 2019). The traditional management of the communal upland habitats that created these landscapes has been supported, at least in the past, by strong systems of social capital and the generational passing on of human capital, which comprises the knowledge, skills, tradition, practices and motivations, that are the cultural products that farmers use to maintain the iconic landscapes of the UK (Burton et al., 2006). Socio-cultural shifts and shifting tourist demands are changing the social dynamics of the uplands (Burton et al., 2006). These changes, combined with the out-migration of young people in the farming community and an increase in numbers of 'amenity migrants', higher income earners and retirees making lifestyle decisions to buy property in the uplands, is weakening the social capital of an already fractured and ageing communities (Reed et al., 2009). There are fewer and larger hill farms and a reduction in farmer and farm worker numbers (Harvey et al., 2013). This leads to a reduction in certain co-operative activities including participation in the local community, harvest activities such as hay and silage making, shearing, fell gathering (the gathering of sheep from the fell for welfare and lambing activities) and access to social capital (Burton et al. 2006). There is a danger as policy moves towards a 'public money for public goods' approach to land management that upland farming could become a by-product of an ecosystem service delivery agenda, with livestock grazing becoming a management tool instead of being the primary focus on the farm (Mansfield, 2018).

This in turn may impact upon the cultural capital being provided by these traditional farming communities. Some 73% of the English uplands fall within protected landscape areas, so it is important to note that National Park Authorities (NPAs) believe that the financial viability of extensive livestock farming must be secured if the special qualities of National Park landscapes are not to become diminished. Therefore, a failure by policy makers to address the socio-economic characteristics of the uplands and the driving forces influencing behaviour of land managers may jeopardize the continued provision of ecosystem services to society (Hubacek et al., 2009).

This thesis uses a combination of qualitative and quantitative experimental work, GIS based analysis and legislation and research review to explore how policy change will impact on the sustainability of the uplands.

1.2. Thesis aims

This section details the aims and objectives of this thesis, followed by a brief description of the relevant chapters and experimental work referring to each objective. This thesis is divided into nine chapters as a series of six experimental papers and one review chapter. A list of the experimental chapter titles is presented in section 1.3.

1.2.1. Thesis aims and objectives

This PhD thesis broadly focuses on agricultural policy change and the sustainability of farming in the uplands focusing on the social, human and natural capital aspects of adapting to policy change.

2.5.5. Objective 1

To assess Pillar 1 payment structure and distribution and explore the potential impacts that subsidy removal may have on land use in Wales.

Data collected through Farm Business Surveys (FBS) enables benchmarking and the monitoring of changes to average farm income that occur over time. However, large farms receiving substantial Pillar 1 payments can heavily skew average incomes, concealing considerable national variation in farm level incomes (WG, 2017a). Variation in payments exists both between and within farm types (Defra, 2017a; SG, 2018; WG, 2017b) making it difficult to predict the number of farms likely to be impacted by the removal of Pillar 1 subsidies using just FBS/FBI average farm incomes. In Chapter 3, I aim to remove some of this variation through an analysis of the CAP payments dataset (Defra, 2017b) and a Welsh Statistical Office (WSO) dataset which combines June Agricultural Survey (WG, 2017a) with Rural Payments Wales (RPW) records for farms in receipt of Pillar 1 payments in 2017 (WG, 2017c). As details for common land and its usage are not included in the dataset this chapter does not include any payments relating to common land. I also use the results of this study to explore the potential impacts that subsidy removal may have on land use in Wales.

2.5.5. *Objective 2*

To conduct an analysis of the current Pillar 2 payment structure and agri-environment scheme (AES) design and uptake in order to identify strengths and weaknesses within the current system.

In Chapter 4, I aim to determine if current action-based AES are an effective means of delivering ecosystem services, using Wales as a case study. I achieve this by using secondary data analysis techniques to unravel the complexities of AES funding, distribution, and scheme structure. GIS was used to explore the spatial scale and uptake of AES management options for the Glastir Entry, Advanced, Commons and Woodland Creation and Restoration Schemes. I discuss the findings to establish if the payment distribution and option management structures of AES, currently funded through the CAP are providing the effective ecosystem services delivery as originally intended or are do they only act as additional income support streams for farmers in low production areas. In conclusion, I suggest how a UK exit from the EU can provide policy-makers with the opportunity to design AES which can effectively deliver '"Public Goods"' whilst subsequently providing farmers with the additional human and social capital needed to fully support social, economic and cultural objectives in Wales.

1.2.4. Objective 3

To enhance government understanding on farmer intentions to join the Countryside Stewardship Scheme (CSS) when Environmental Stewardship Scheme (ESS) contracts expire and to identify what barriers, perceived or actual, exist to prevent a transition to CSS from ESS. The research also aims to add insight into how barriers to AES uptake may be overcome through the decentralisation of national schemes.

As part of the post-Brexit transition process, the Department for Environment, Food and Rural Affairs (Defra) has started a series of tests and trials in preparation for the first pilot of its new Environmental Land Management Scheme (ELMS) which will begin in 2021 (Defra, 2018). The North York Moors National Park Authority (NYMNPA) has been selected, along with several other organisations, to conduct research on behalf of Defra that will help to inform the pilot. Part of this research aims to enhance government understanding on farmer intentions to join CSS (Mid and higher tiers) when ESS contracts expire and to identify what barriers, perceived or actual, exist to prevent a transition to CSS from ESS. Data collection related to on-farm AES participation; it did not included involvement in collaborative commons AES agreements. In Chapter 5, I deliver on these research objectives for the NYMNPA through the results of a series of in-depth interviews conducted with farmers across various farm types and AES participation categories.

1.2.5. Objective 4

To identify farmer attitudes to subsidies and future farming practice when faced with significant changes to agricultural policy.

In Chapter 6, I aim to provide policymakers a snapshot view of farmer attitudes towards future policy change by identifying farmer attitudes towards Brexit, subsidies, public goods and future farming practices and making links between positive and negative attitudes and demographics.

1.2.6. Objective 5

To conduct a social capital analysis to identify farmer willingness to obtain bridging social capital with other rural stakeholders in order to increase farm resilience and adjust to policy change.

In Chapter 7, I aim to contribute to current literature by using a mix of qualitative and quantitative research methods in a series of interviews with UK farmers across differing locations and categories to ascertain how levels of social capital may hinder or enhance a farmer's willingness to embrace future agricultural policy.

1.2.7. Objective 6

To assess the environmental, economic and social benefits to be gained from farms which are making a change from 'traditional' production-based farming practices on upland farms to those which adopt sustainable land management practices.

In Chapter 8, I aim to use a Welsh Statistical Office (WSO) dataset which provides detailed data from June Agricultural Survey on farm structure and livestock numbers (WG, 2017a) and case study farms to show what farming in the uplands might look like in the future if environmental and economic sustainable practices are fully applied. The territorial boundaries for the assessment include farms across the upland and lowland beef and sheep grazing livestock sector in Wales but excludes common land as the data set does not contain details for common land and its usage. The case study farm used for this study will not be exercising any rights to graze common land. I will assess the social and environmental benefits to be gained by making the change to these sustainable practices.

2.5. Experimental chapter information

The experimental chapters of the current thesis have been prepared in the style of journal articles. The title page of each experimental chapter includes details of the authors, author contributions to the manuscript and the current progress of each manuscript (e.g., published/accepted/submitted/not yet submitted). The thesis consists of six experimental chapters located in Chapters 3-8 of the current document. For continuity and clarity, the experimental chapters will be referred to as they appear in this thesis. The titles of the experimental chapters are as follows:

Chapter 3: Vulnerability of British farms to post-Brexit subsidy removal, and implications for intensification, extensification and land sparing.

Chapter 4: What can management option uptake tell us about ecosystem services delivery through agri-environment schemes?

Chapter 5: Overcoming barriers to CSS uptake through the decentralisation of agri-environment policy.

Chapter 6: Agricultural policy change and the future of UK farming – A survey of farmer attitudes.

Chapter 7: Importance of building and linking social capital in adapting to changes in agricultural policy.

Chapter 8: Exploring viable upland farming systems compatible with net zero carbon targets.

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Chapter 2

Literature Review

2.1. Introduction

2.1.1. Sustainable development

At the heart of sustainable development strategy are three interlocking pillars (Environmental protection; Social sustainability and Economic sustainability; Brundtland, 1987) and these can clearly be seen in policies being implemented across the UK. In Wales, the 'Well-being of Future Generations (Wales) Act (WG, 2015) states, "sustainable development" means, "the process of improving the economic, social, environmental and cultural well-being of Wales by taking action, in accordance with the sustainable development principle, aimed at achieving the well-being goals":

- A prosperous Wales.
- A resilient Wales.
- A healthier Wales.
- A more equal Wales.
- A Wales of cohesive communities.
- A Wales of vibrant culture and thriving Welsh language.
- A globally responsible Wales.

English policy adopts the widely used international definition, "Meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987; HM Government, 2005) stating that sustainable communities should be;

- Active, inclusive and safe – fair, tolerant and cohesive with a strong local culture and other shared community activities.
- Well run– with effective and inclusive participation, representation and leadership.
- Environmentally sensitive– providing places for people to live that are considerate of the environment.

- Well connected– with good transport services and communication linking people to jobs, schools, health and other services.
- Thriving – with a flourishing and diverse local economy.
- Well served– with public, private, community and voluntary services that are appropriate to people's needs and accessible to all.
- Fair for everyone– including those in other communities, now and in the future.

The UK uplands have a vital role to play in the UK and Welsh government's sustainable development, environmental and climate change strategies (HM Government, 2005; WG, 2015; Defra, 2018a; CCC, 2019; WG, 2019; Defra, 2020a; NAO, 2020). They provide a multitude of ecosystem functions and services that are essential to our daily life and support land-based industries that are essential for the social fabric and economies of rural communities, such as:

- Farming
- Forestry
- Leisure pursuits, including tourism and field sports

In addition to environmental services such as clean water, carbon storage and flood management the uplands also provide 'Cultural Ecosystem Services' (CES), which are "non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" (Millennium Ecosystem Assessment, 2005). These can improve physical health outcomes via changes to psychological wellbeing (Clark et al., 2014) and potentially motivate people's willingness to conserve natural environments and can have consequences for conservation practices (Gobster et al., 2007; Dickinson and Hobbs, 2017). If governments are to successfully access these ecosystem services and deliver on sustainable development goals it is crucial that the upland communities that mange these landscapes are themselves, economically, socially and environmentally sustainable. This review will begin by describing the structure of the uplands from landscape to farm level before exploring the economic, social and environmental challenges and opportunities facing upland farming communities.

2.1.2. The UK uplands

Although there is general agreement about their attributes and characteristics, there is no statutory definition of uplands (Environment, Food and Rural Affairs Committee, 2011). Upland landscapes are both natural and human; they are 'cultural landscapes', living history representing human intervention, human activity and values. They have been created by centuries of human endeavour and are maintained by continued stewardship (Commission for Rural Communities (CRC), 2010). Land categorised as "Less Favoured Areas (LFAs)" – a European designation used for areas with natural and socio-economic disadvantages, is commonly used to define the uplands as it largely corresponds to areas of uplands farming systems (CRC, 2010; Defra, 2011). LFAs are further divided into two distinct classifications: Disadvantaged Areas (DAs) or Severely Disadvantaged Areas (SDAs; Defra, 2011). In both types, agricultural production is either severely restricted or restricted in its range by virtue of the adverse soil, relief, aspect or climate, or by a combination of these (Backshall et al., 2001). The proportion of LFA in the farmed area in England is 12%. In Wales and Scotland, it is much higher at 78% and 84% respectively (CJC Consulting, 2003). Within the LFAs, agricultural land comprises a high proportion of Grade 4 and 5 land, i.e., poor, or very poor agricultural land (Backshall et al., 2001). Fig. 2.1 shows the distribution of the uplands throughout the UK.

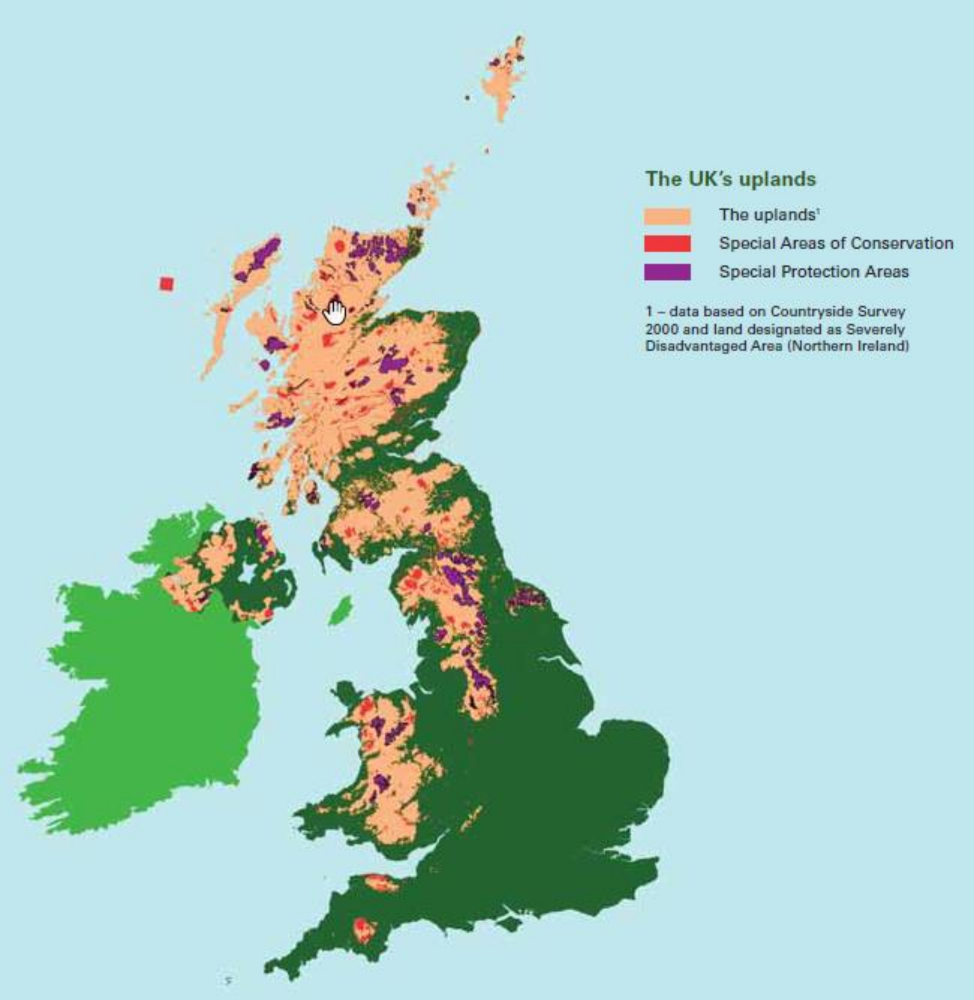


Figure 2.1. The upland areas of the UK (areas with altitude >300m in England and Wales, Less Favoured Areas categorised as "Severely Disadvantaged" in Scotland and Northern Ireland), special areas of conservation and special protection areas. (Source: RSPB).

The low land productivity of these areas reflects a limited production set which constrains the ability to generate a sustainable household income directly from agricultural production (Barnes et al., 2020). High proportions of LFA land are also in remote regions which has social effects in terms of isolation, limited access to health services, broadband and transportation links, but also economic effects as there are limited opportunities for non-farm employment (Dax, 2005; Barnes et al., 2020).

2.1.3. *Traditional upland farming systems*

Upland farms typically include the following types of farmed land (Backshall et al., 2001; Mansfield, 2011; Fig 2.2):

- In-bye land – enclosed pasture and hay meadow, usually in the valley bottom and 'in by' the farm, which is accessible to farm machinery and may have been cultivated by ploughing, reseeding or fertilising.
- Intake land (Ffridd in Wales) – enclosed land which usually consists of agriculturally poor- quality, unimproved pasture 'taken in' from the hill and consequently adjacent to moor or fell land (although it may also include some agriculturally improved land).
- Moor or fell land – unenclosed, unimproved grazing above the fell wall which consist of dwarf shrubs, blanket and other mires, grassland and montane vegetation.

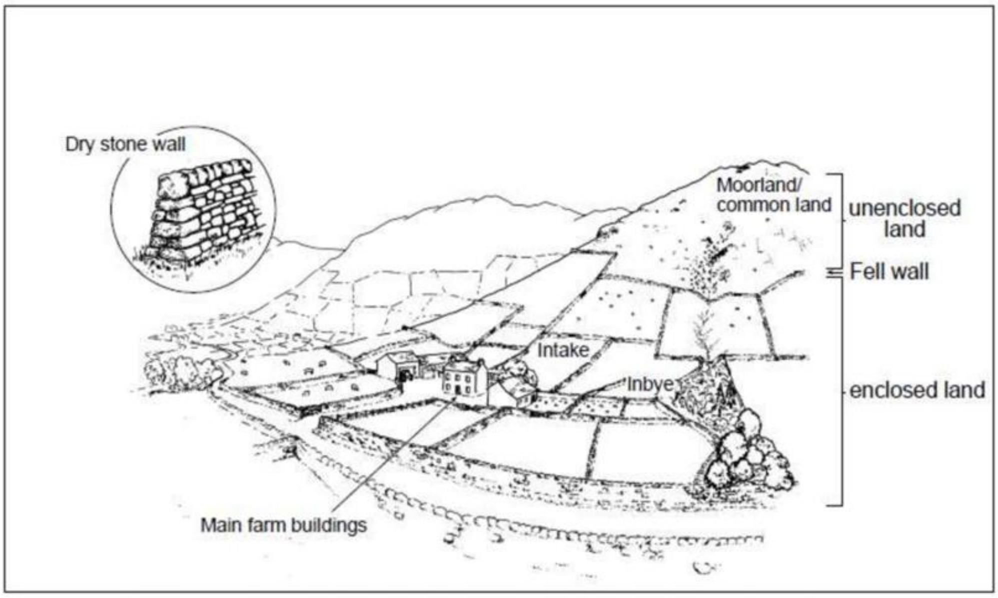


Figure 2.2. A typical upland farming landscape. (Source: Mansfield, 2011).

Farmers incorporate these land types into their farm management system giving them the flexibility to overcome the poor physical conditions they face. The proportion of each land type on farms influences farming practice creating specific farm typologies (Mansfield, 2008; Mansfield, 2019):

- Dairy farms: Mainly in-bye and intake land. These farms are confined to the upland margins.
- Upland farms: Divided into two types; true upland farms containing inbye, intake and fell and,
- The hill farm, which contains intake and fell with little or no inbye. This tends to restrict hill farms to traditionally running just sheep, whereas the true upland farms have historically run sheep flocks and cattle herds in combination. Hill farmers across England earn about half the income per farm of their lowland peers (Harvey et al., 2013).

An upland system typically comprises a combination of cattle as well as sheep, with the cattle helping to maintain the quality of the pasture through grazing areas where the vegetation is too rough for sheep and clearing bracken through trampling (Burton et al., 2005). Upland farm cattle are predominantly suckler cow herds which are used to produce beef calves. While the hardy breeding animals can graze the moor all year-round, their progeny will usually graze the hills only during the summer, and in winter they will be moved down to lower-lying pastures, prior to sale off the holding or recruitment into the breeding flock or herd, in the following year (Short and Dwyer, 2012; Mansfield, 2018). However, a combination of political and economic drivers has seen a shift from a traditional mixed livestock economy towards mainly sheep rearing (Mansfield, 2018). Livestock breeds vary from upland to upland as traditionally native stock were bred to cope with local environmental conditions (Mansfield, 2018). Most of the ewes in a hardy sheep flock are crossed with less hardy but bigger breeds to produce crossbreed flocks. Traditionally (certainly since the mid-20th century), most half-hardy ewes would be sold to lowland farmers as breeding stock, and the male lambs sold as 'stores' to be fattened on lower, more productive land (Short and Dwyer, 2012). Moorland/fell provides summer grazing with the sheep being hefted to the common land in which they graze.

Common land is land owned by one or more persons where other people, known as 'commoners' are entitled to use the land or take resources from it (Defra, 2015). The right of a commoner to take resources from a piece of common land is called a right of common. A right of common can be (Defra, 2015):

- pasturage – the right to put livestock out to feed on the land, usually grass but can be heather or other vegetation.
- pannage – the right to put pigs out to feed in wooded areas of the land.
- estover – the right to take specific timber products from the land, like whole trees or firewood
- turbary – the right to take turf or peat from the land to burn as fuel
- piscary – the right to take fish from ponds, lakes, rivers and streams
- rights in the soil – the right to take soil or minerals from the common and,
- animals ferae naturae – the right to take wild animals

Common land makes up 3% of the land area of England, 5% of Scotland and 8% of Wales and it provides a wide range of public goods (Mansfield, 2018). Pasturage common rights give farmers the right to graze a heft, which is an area of land in which livestock innately graze through learned behaviour (Mansfield, 2018). Sheep were historically shown the heft by shepherds and dogs who would repeatedly herd the sheep within the heft boundaries. Over time, the adult sheep would learn to remain within the heft boundary and, as lambs were born, they would pass the knowledge from generation to generation (Mansfield, 2018). However, reductions in available labour (Franks et al., 2019) means that the management of common land is increasingly time consuming, and many farmers are no longer exercising their rights to graze (Mansfield, 2018). It is estimated that the number of full-time farmers and commoners will continue to decline in the uplands and in recent years there have been calls for the complete removal of upland sheep farming from the commons (Mansfield, 2018). Upland commons will have a role to play in future plans to reduce carbon emissions and increase biodiversity but the range of public goods currently being provided from common land is dependent on continued grazing and collaborative management. If grazing livestock are removed for the commons this will potentially lead land abandonment and a decline in public good provision and cultural landscapes (Mansfield, 2018).

Each of the different upland regions of England and Wales has a distinct character but farming, in particular livestock farming, is core to each (NFU, 2013a). Wales is characterised by upland and mountainous topography and is subject to a wetter climate than much of the rest of the UK. As a result, a large proportion of utilised land is considered LFA (80%; NFU, 2013a), Agriculture in Wales is heavily focused on the grazing of livestock, specifically sheep, on LFA land in comparatively small farm holdings that make relatively modest incomes. A similar structure is found in both Scotland and Northern Ireland, but the English sector in characterised by a significantly higher proportion of cropland agriculture on holdings with larger land sizes that generate a greater than average income.

In the North York Moors (NYMs) and Yorkshire Dales, upland livestock farming makes an especially significant contribution to maintenance of the environmental qualities of Areas of Outstanding Natural Beauty (AONB) and National Parks, which together comprise more than 45% of North Yorkshire (Harper et al., 2015). The Yorkshire Dales are characterised by many small family livestock farms, dominated by those categorised as LFA livestock units (mainly extensive beef and sheep farms). 82% of farms in the Yorkshire Dales are classed as LFA livestock (Harper et al., 2015). Farms and farming systems in the NYMs are characterised by family farms that still dominate but there is a more varied mix of farm types because of the different soils, topography and climate. LFA livestock farms represent only 44% of total farms in the North York Moors National Park (NYMNP) area and there are a higher proportion of farms that are categorised as dairy, cereals and lowland livestock (Harper et al., 2015). In 2103, the average hill farmer in the Lake District National Park was 56 years old, with 94ha of inbye land, 236ha of rough grazing and 14ha of woodland, with access to common grazing equivalent to about ¼ of its own rough grazing. However, in some cases, farmers were no longer choosing to exercise common grazing rights as farming practices shifted to systems that required a lower labour input (Harvey et al., 2013). In England, the average grazing livestock farm has 165 ha of enclosed land and typically has access to an area of common land. It is part owned (78 ha) and part rented (94 ha) and most of the farm (96 ha) is in permanent grass. The average LFA farmer is 61-year-old, has 26 beef cows and 383 breeding ewes. Cattle and sheep youngstock and fatstock make up the total to 83 cattle and 752 sheep on the farm, making a total of 90 Grazing Livestock Units. The average LFA grazing livestock farm earns 59% of its total revenue (output) from crop and livestock farming activities, 25% comes from the basic payment and 11% from agri-environment payments. The balance of revenues (5%) is earned from diversification activities (Harvey and Scott, 2020). The differences in farm structure and natural constraints across the country means that the availability to adapt and change varies from farm to farm and across the UK upland areas. Agriculture typically has an aging workforce. In the United Kingdom, around a third of all holders were over the typical retirement age of 65 years while the proportion of young people aged less than 35 years was around 3% (Defra, DAERA, WG and SG, 2020). The 2017/18 Farm Business Survey identified 43% of farmers having a nominated successor. These farms were more likely to be larger farms and older farmers. The successor was largely from within the family (40%); with a further 1% percent stating that the business would continue outside of the family. The remaining 2% had a nominated successor but they would be unable to take over due to tenancy or other issues (Defra, 2018c).

2.1.4. A comparison between the upland farming systems of Wales and the North York Moors

This study focuses predominantly on two upland areas, North Wales, and the NYMs.

2.1.4.1. *Farming in the Welsh Uplands*

Of the 2.1 million hectares of land in Wales, the land on farms and commons (~1.9 million ha) represents 88% (WG, 2016). Around 80% of the agricultural land in Wales is categorised as LFA (~1.35 million ha) with 435,147 ha in DAs (32%) and 911,303 ha (68%) in SDAs, which is the second highest proportion of LFA land in the UK. Scotland has 84% LFA land, whilst England has the lowest at 16% (WG, 2019a). Most of the agricultural land in Wales is permanent grass or rough grazing which is divided into sole grazing rights and common grazing rights (Table 2.1). The hills and uplands of Wales (200m – 1,085m) can be defined as agricultural land covered by LFAs and areas of traditionally stock-based hill farming and their associated lowland pasture (Fowler et al., 2004).

Table 2.1. Agricultural land in Wales and the North York Moors.

	Wales		North York Moors	
	Total Hectares	%	Total Hectares	%
Arable (a)	247,059	13	20,725	19
Permanent grass	1,065,602	57	49,363	46
Rough grazing (sole rights)	260,196	14	16,887	16
Rough grazing (commons)	180,305	10	15,609	14
Woodland on agriculture holdings	89,171	5	4,756	4
Other	15,044	1	831	1
Total	1,857,377	100	108,171	100

(a) Arable includes grassland temporary grassland and fallow (Source: Hildreth, 2019; Welsh Government 2019a).

Cattle and sheep farms in the LFA are the dominant farm type in Wales (31% of all active holdings in 2016; WG 2019a) and occupy the largest share of agricultural land in Wales (46% of land; Table 2.2). There are three main categories of sheep and beef farm in Wales, the hill farm, which is mainly in the SDA, the upland farm, mainly in the DA and lowland farms which are mainly outside of the LFA (Fowler et al., 2004). Hill farms typically have 60-95% of the land in semi-natural rough grazing, often with access to common lands, whereas upland farms have >30% of enclosed sown pastures (Fowler et al., 2004).

Table 2.2. Number of hectares of total area and average farm size by farm type in Wales, 2016.

Type of farming	Number of hectares (total area)	Average Farm size (hectares)
Cereals	39,579	152
General cropping	11,372	124
Horticulture	4,353	23
Specialist pigs or poultry	4,501	38
Dairy	185,574	114
Cattle and sheep (LFA)	764,654	117
Cattle and sheep (Lowland)	81,562	70
Mixed	47,499	119
Other types	11,386	65
Part-time/very small	210,441	15
Dormant holdings	316,153	25
Active Holdings	1,360,919	55
All types	1,677,072	45

Most cattle and sheep farms are in the very small or small category with the numbers of holdings decreasing the larger the farm (Table 2.3). The average farm size for LFA cattle and sheep farms is 117 ha but SDA hill farms are often larger with more average forage area (the area of the farm available for the feeding of livestock, including grazing, grass conservation and fodder crops; Jenkins, 1983) than upland DA farms (Hybu Cig Cymru – Meat Promotion Wales, 2019).

Table 2.3. Total number of Welsh farm holdings in the cattle and sheep LFA and Lowland categories for 2013 and 2016.

	2013		2016	
	Cattle and sheep (LFA)	Cattle and sheep (Lowland)	Cattle and sheep (LFA)	Cattle and sheep (Lowland)
Very Small	5,848	1,359	5,420	1,311
Small	4,872	906	4,608	909
Medium	1,486	212	1,596	212
Large	180	31	264	38
Very Large	30	4	41	7
Total	12,416	2,512	11,929	2,477

Rights of access to common grazing are more often a feature of hill farms than upland farms, and flocks of ewes are often maintained in hefts, where sub-flocks habitually graze a particular part of the hill (Fowler et al., 2004). However, a decline in the number of active graziers and important and worrying changes in the pattern of succession, which see fewer farmers exercising grazing rights, could see common ground in the hills being abandoned (Brackenbury and Jones, 2015).

Typical Welsh hill and upland agricultural landscapes can be divided into four main areas (Roberts and Kelly, 1994):

- The *gwaelod* or bottom-land which offers the best pasture. It will probably have been 'improved' by being drained, reseeded, or artificially fertilised. In the past, it probably would have grown some crops (cereals and potatoes).
- *Garth* is localised, less accessible, uncultivated land, usually distinguished by its roughness. It may be wooded in areas where it is relatively inaccessible, and this may be more by chance than design. The lack of incentives to encourage the positive management of farm woodlands has meant that many woods remain unfenced, overgrazed, and neglected.
- *Ffridd* is enclosed hill land between the better-quality lower land of a farm and the open mountain or mynydd. Ffridd land, managed as grazing for sheep and cattle will have been 'ploughed out' of the mountain and fertilised intermittently with dung. It has been the target of interest among foresters whose conifer planting since the early 1920s has blanketed huge swathes of upland Wales. The Welsh Government (2018) plan to increase woodland cover in Wales by at least 2000 hectares per annum from 2020 to 2030 and beyond to meet strategy priorities and to maintain the overall productive potential from Welsh woodlands. Ffridd land

has been identified as a target area for future woodland planting (Welsh Government, 2021).

- *Mynydd* or mountain land provides the summer sheep walks for hill farms. Traditionally, but now less frequently, grazed in common, mountains provide habitats for some of our rarest wildlife.

In the hills and uplands of Wales, a traditional system of farming was based on the practices of hendre (lit. the old homestead) and an accessory station, the hafoty (lit. the house on, at, or of, the hafod, which was then the name of the summer grazing area). The hendre was a family settlement occupied and farmed by a kindred group (gwely), and it comprised two or three or more dwelling houses set beside their tilled land which was handed on from generation to generation according to clear rules of partible succession (Davies, 1984). In winter months livestock were housed at the hendre and in summer months the livestock and the gwely would move to the hafod (hill farms) which were utilised for summer pasturage, predominantly for cattle which were the mainstay of the rural economy, and rarely for finishing stock (Davies, 1979; Davies, 1980; Davies, E., 1984; Fowler et al., 2004). This historic system of transhumance, where hill farms produced calves and lambs that were sold to lowland farms for finishing, was replaced by an integrated system of production during the Great Enclosure Movement of the eighteen century which saw ~20% (1,000,000 acres of common land) of the total surface area of Wales being brought into private occupation. It was during this period that the Ffridd was created (Roberts, 1959).

More recently there has been an emphasis on sheep-only systems, or sheep and beef systems where beef are the minority stock on the holding (Fowler et al., 2004). Like other UK upland systems, Wales operates a stratified sheep system characterised by a three-tier breeding structure related to altitude and grazing (Fig. 2.3; Hybu Cig Cymru – Meat Promotion Wales, 2004). The first tier is in the hill areas where ewes of the hill breeds, e.g., Hardy Speckle-faced and Welsh Mountain are maintained in self-contained flocks under relatively harsh conditions. Surplus breeding stock from these flocks in the form of cast ewes are transferred into the uplands, the second tier of the industry, where they are crossed with specialised long-wool ram breeds, such as the Blue-faced Leicester and Border Leicester. The first-cross ewe lambs are transferred to the lowland areas, the third tier, where they are generally crossed with rams of the terminal sire breeds, e.g., Suffolk, Texel and Charollais, to produce slaughter lambs. Although this is the general trend there are many regional variations.

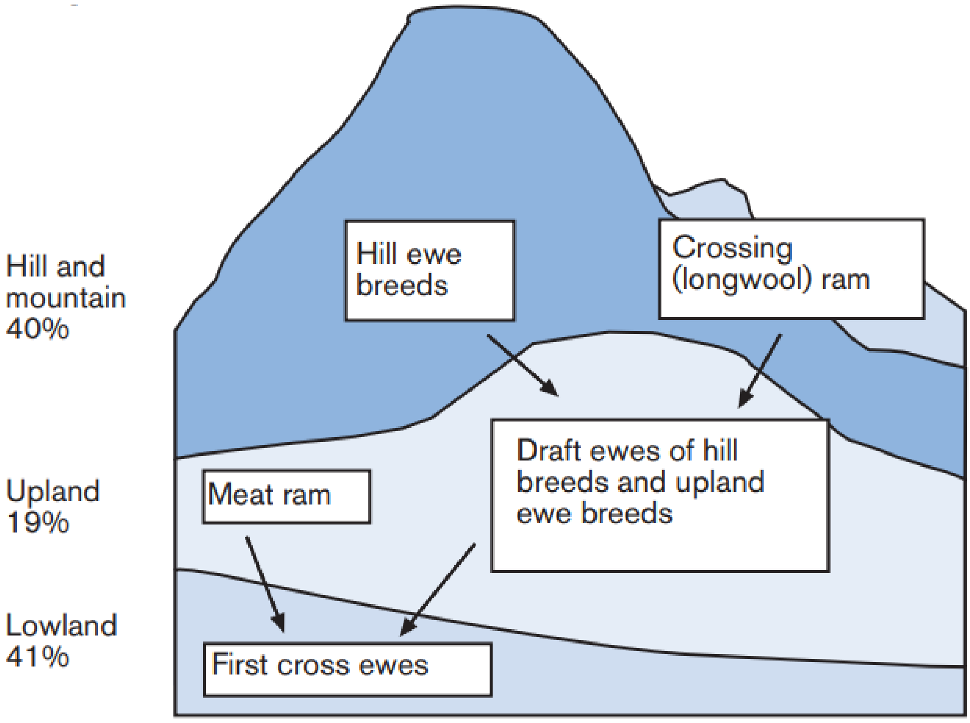


Figure 2.3. Proportion of ewes in a Welsh stratified sheep system.

In some areas of Wales e.g., the Cambrian Mountains, some traditional breeds are being branded as sustainable breeds, with a view to add value to the product and increase farm viability. 'Cambrian Mountains Lamb' are produced on Farm Assured farms or similar and are bred from ewes that are a minimum of 80% Welsh Mountain or from other Welsh native hill breeds. Most flocks would be from traditionally Hefted flocks. All "Cambrian Mountains Lamb" producers have adopted the traditional "Hafod a Hendre" system with all the sheep staying near the farmstead during the winter months and grazing the mountain land during the summer and autumn, although the farmer no longer lives on the hill alongside the sheep, instead the sheep would be gathered for shearing, counting or treatment. The exact length of grazing on the hill/mountain is dependent upon weather, but all “Cambrian Mountains Lamb” would graze the hill/mountain for a minimum of 3 months and often up to 5 months (Cambrian Mountains Lamb Group, 2012)

Figure 2.4 shows <40% of LFA cattle and sheep farms stocking cattle (Hybu Cig Cymru – Meat Promotion Wales, 2020). Most beef cattle are in the lowlands or DAs. In the SDA, the density of beef cattle is <0.1 ha (Fig. 2.5).

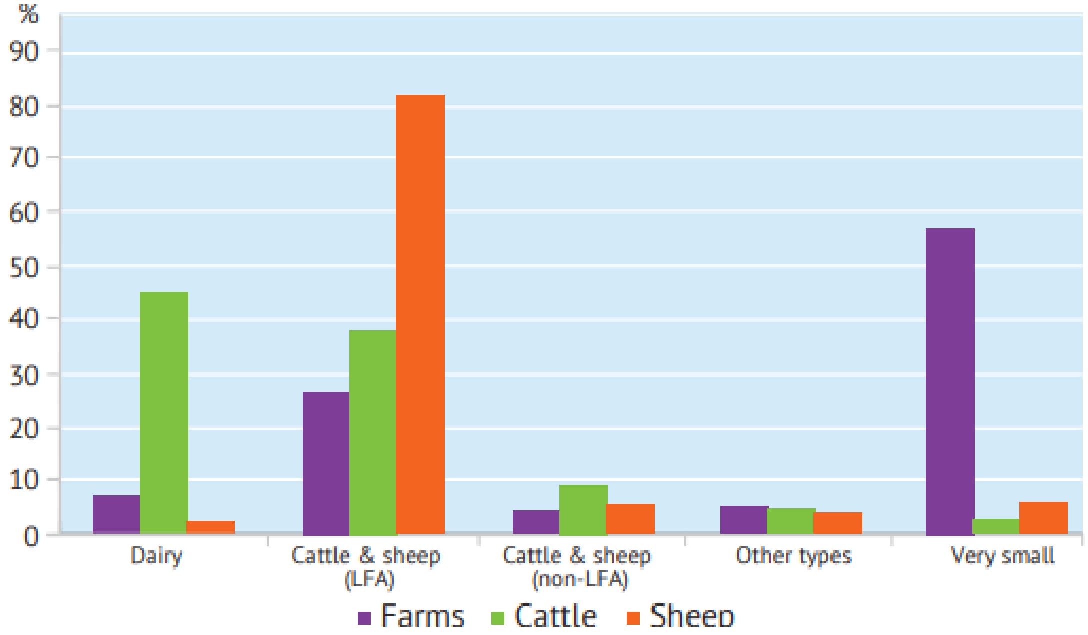
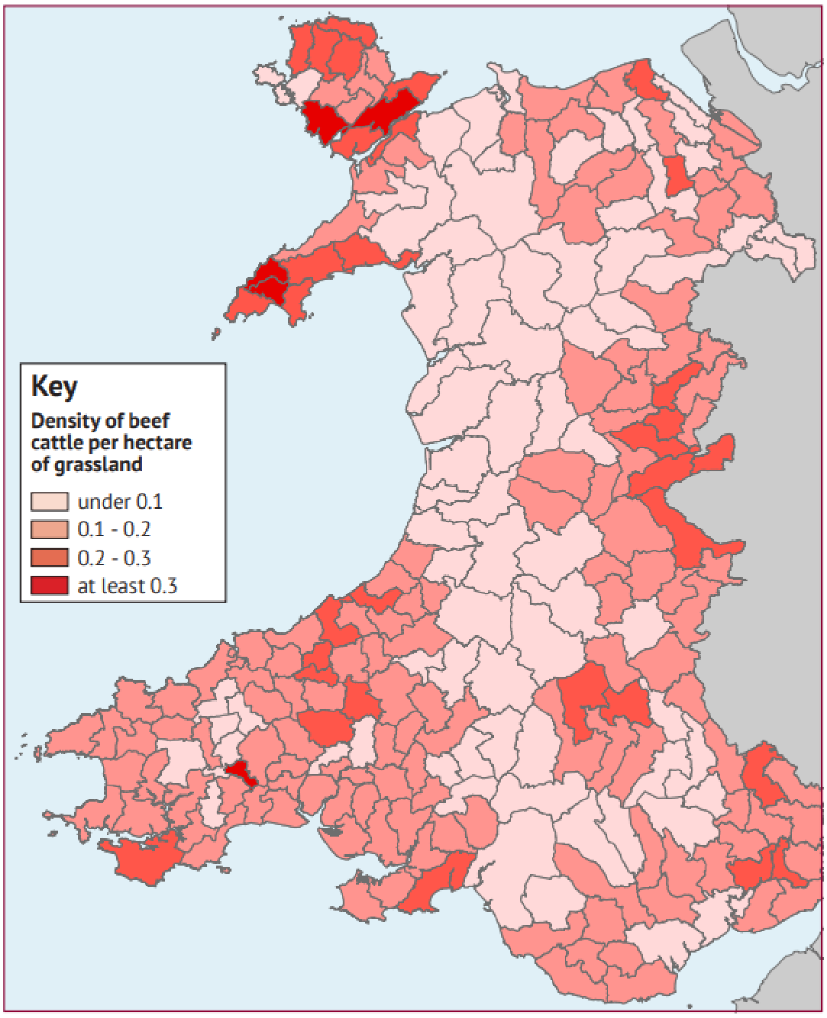


Figure 2.4. Distribution of farms, cattle, and sheep by farm type 2019. Source: Welsh Government in Hybu Cig Cymru – Meat Promotion Wales, 2020.



Source: GI Services Branch, DEPC, Aberystwyth © Crown copyright

Figure 2.5. Beef cattle density in Wales, June 2018.

Historically, traditional cattle breeds of Wales were predominately the Welsh Black and Hereford. These breeds remain at the foundation of the Welsh beef industry today. Welsh beef is derived from the traditional breeds of Wales and these breeds crossed with each other or with any other recognised breed. The distinctive characteristics of Welsh beef are due to the influence of the traditional breeds which remain at the foundation of the Welsh beef industry and to the cattle feeding on the abundant natural grassland in Wales, which flourishes because of the wet and mild Welsh climate and topography. The efficient production and use of grass is central to the well-being of Welsh beef production (Hybu Cig Cymru – Meat Promotion Wales, 2006).

2.1.4.2. *The farm business*

Tenant farmers and land rental agreements are an important part of agriculture in Wales. Nine percent of holdings that applied for BPS and/or Glastir (the Welsh AES) in 2018 were farms that applied with wholly tenanted land, whilst 39% of holdings applied with both owned and rented land. Fifty-two percent of holdings owned all the land that they applied with. Of the total amount of land in Wales for which BPS and/or Glastir claims were made, over a quarter was for land that was rented. The Farm Business Survey (FBS) estimates that 35% of rental agreements in 2017-18 were for less than 1 year (WG, 2019a). Most principal farmers in Wales are over the age of 55 (68%) with a median age of 61, whilst 3% are under 35 years old (WG, 2019a). A Wales Rural Observatory Survey (2010) found that 60% of the households sampled, had a likely successor to the farm, while 47% had family succession plans. In 2011/2012, 41% of UK upland farms had succession secured, almost entirely within the family. The main reasons for succession arrangements not being in place were a lack of interest from family or that there was no family to pass the farm business on to. Some families have been farming in the hills and uplands for generations with first or second succession rights applying (NFU, 2013b).

57% of farm holdings in Wales are classified as ‘very small’, meaning that they do not provide enough work for one full time worker. This means two things: firstly, that these farms are not included in FBS and they are unlikely to be affected by its removal as part of agricultural policy reform but also that these farms are likely to have alternative sources of income such as off-farm employment and income of spouses (WG, 2019a). These additional sources of income are likely to influence on-farm decisions and therefore make responses to changes in market conditions difficult to predict (WG, 2019a). Off-farm income is a source of income for all farm sizes, but it decreases in importance the larger the farm gets (WG, 2019a). Table 2.4 shows

LFA cattle and sheep farms making negative income from the farming enterprise suggesting that farm profit must come from other areas of the farm business (WG, 2019a).

Table 2.4. Average income from agriculture by farm type (£).

	2014-15	2015-16	2016-17	2017-18	Difference between highest and lowest income
All farms	3,400	-1,300	-1,900	5,900	7,800
Dairy	49,200	15,200	12,800	62,400	49,600
LFA cattle and sheep	-6,000	-4,500	-6,200	-5,200	1,700
Lowland cattle and sheep	8,300	1,400	4,100	4,900	6,900

Source: Reweighted population estimates from the Farm Business Survey

Diversification, described as non-agricultural activity that uses farm resources, provides a source of income for some farms (Table 2,5; WG, 2019a). The number of farms engaged in diversification has increased 80% since 2009-10 but only 39% of farms surveyed for the Farm Business Survey are currently engaged in diversification activities making them the minority. The FBS definition of diversification only covers enterprises operated as part of the farm, not incomes earned by household members from non-farm work, which may also be significant. The 2013 farm household income survey (WRO, 2013) found that half had diversified incomes and 41% had non-farm incomes (Dwyer, 2018). An increase in diversification into renewable energy, rural crafts and non-agricultural contract work highlights the potential for other farms to diversify as BPS payments reduce. Agri-environment payments provide a valuable source of income, especially for LFA cattle and sheep farms who, on average, receive the largest amount form AES (Table 2.5; WG, 2019a). Income from the BPS is highest in the LFA cattle and sheep sector who are likely to be most impacted by its removal (Table 2.5; WG, 2019a). Scenarios which see the UK having free trade with EU, then with others, but direct financial support being cut by 60%, estimate that most beef and sheep farms will become economically inviable if they are not able to increase income from other income sources.

Table 2.5. Breakdown of average income by income source and farm type for 2017-2018 (£).

Income source	All farms	Dairy	LFA cattle and sheep	Lowland cattle and sheep
Diversification	3,200	1,600	3,100	2,500
Agri-environment	4,900	1,700	6,300	2,300
Basic payment scheme	20,500	16,700	22,700	14,200
Income from farming	5,900	62,400	-5,200	4,900
Total	34,500	82,400	26,900	23,900

Source: Agriculture in Wales (WG, 2019a)

2.1.4.3. Farming in the North York Moors

Whilst the uplands of Wales rise to 1,085m above sea-level, the NYMs consists of upland plateau, generally below 400 m. 76% of the NYMs is LFA. This is made up of 15% DAs and 61% SDAs. The area is dissected by a series of broad and sweeping dales with steep sided river valleys in places. Extensive areas of heather moorland are present which provide a sense of wilderness, grazing for upland flocks and an ideal landscape for game shooting. Like Wales, the valley landscapes of the NYMs are characterised by pastoral farming, with a clear demarcation and strong visual contrast between the enclosed fields with some species-rich grasslands and wetlands, farms and settlements, and the bracken-fringed moorlands above (Natural England, 2015). Arable areas are mainly concentrated to the south and east, settlements generally occupy the dales and park fringes, and the dramatic landscape of the North Sea coast sits to the east. Farmsteads are generally of rubble limestone or dressed sandstone construction and boundaries are commonly dry-stone walls with hedges in more sheltered dales (Hildreth, 2018). Agricultural land in the NYMs LFA can be broken down into three categories (Defra, 2012):

- Moorland – open or enclosed moorland areas including both sole occupancy and commons
- Enclosed rough grazing – lower quality grazing land below the moorland line

- Other grassland – improved and semi-improved grassland areas that form the better-quality grazing land on the holding.

At ~108,000 hectares, the total agricultural area of the NYMs is smaller than the uplands of Wales but there are some similarities in the distribution of agricultural land in both areas (Table 2.1). Permanent grassland or rough grazing (sole rights and commons) makes up most of the agricultural land in both areas, 81% in Wales and 76% in the NYMs. The percentage of agricultural land in woodland or other land use is similar in both areas but the NYMs has 6% more arable land than Wales (Table 2.1). Like Wales, cattle and sheep farms are the dominant farm type in the NYMs (Table 2.6) with the majority being in the LFA (85% in Wales (WG, 2019a) and 71% in the NYMs; Defra, 2021).

Table 2.6. Number of commercial holdings by farm type for Wales and the NYMs (2013/2016).

	Wales		North York Moors	
Type of farming	Number of holdings (2013)	Number of holdings (2016)	Number of holdings (2013)	Number of holdings (2016)
Cereals	234	260	73	79
General cropping	82	92	99	116
Horticulture	190	186	7	13
Specialist pigs or poultry	131	118	32	42
Dairy	1,722	1,628	59	51
Cattle and sheep	7,721	7,676	598	603
Mixed [(a)]	405	398	105	109
Other types	224	174	5	8
Total	10,709	10,532	978	1,021

(a) Combinations of cropping with various types of livestock

Source: WG, (2019); Defra, 2021.

Although numbers of LFA grazing livestock farms still contribute over 40% of the overall number of farms within the NYMs their number has fallen marginally from 432 in 2013 to 429 in 2016 (Hildreth, 2018). Overall, cattle and sheep farms in the NYMs have increased slightly whilst in Wales they have decreased (Table 2.6). Some explanation for a reduction in LFA grazing livestock and an increase in lowland grazing livestock in the NYMs may be the way the data has been collected and the way respondents have completed their June return (Hildreth, 2018). Several farmers will try and benefit from economies of scale with some existing businesses expanding and other business leaving farming or considering changing enterprise. Although the number of holdings has fallen it is likely the case that the same area of land is managed by the same farm type just by larger farms (Hildreth, 2018). There have been reductions in the numbers of all active farm types in Wales, except for cereal and general cropping farms (WG, 2019a).

Specialist intensive units may only need a few hectares to make a business viable whereas an extensive moorland grazing system may reply on farming a very large area to achieve the same. The increase in the <5ha category in the NYMs between 2013 and 2016 (Table 2.7) is likely due to the increase in the number of horticulture, pig and poultry enterprises seen in table 2.6. The increase in holdings of 20ha and under is likely due to the increase of intensive (pig and poultry) and horticultural businesses which rely on relatively small amounts of land. The increase in those farms over >100ha is due to farms increasing in size and trying to maximise economies of scale. In figure 2.7 the over 100ha farms are growing in number whilst those farms between 20ha and 100ha reduce in number as they are swallowed by the larger farms (Hildreth, 2018). Similar patterns are seen in Wales where the numbers of small and very small LFA cattle and sheep farms have reduced between 2013 and 2016 and the numbers of medium to very large farms have increased (Table 2.3). It is clear from data collected as part of the Farm Business Survey (FBS) that efficiencies gained by having a larger dairy herd makes a large difference to Farm Business Income per hectare (Hildreth, 2018). This efficiency is seen across LFA and lowland enterprises in the NYMs with smaller dairy farms being swallowed by larger ones and some dairy farmers switching to grazing livestock farms or pushing to increase their herd size (Hildreth, 2018).

Table 2.7. Number of commercial holdings in the NYMs by total area size group for 2013 and 2016.

Number of holdings by total area size groups	2013	2016
<5ha	63	88
5 <20ha	230	247
20 < 50ha	224	219
50 <100ha	243	218
>=100ha	218	249
Total holdings	978	1,021

Source: Defra (2021)

In Wales, high altitude SDAs and a high percentage of hill farms with limited access to lowland grazing or better-quality agricultural land may limit opportunities to diversify farming practice whereas, in the NYMs lower altitude and access to land outside of the SDA may, as seen in table 2.6, provide farmers with an opportunity to move into more intensive farming practices such as horticulture or specialist pigs and poultry which give relatively high returns from small areas of land.

Historically, the LFAs of the NYMs are best suited to pastoral agriculture, a practice which still exists today. Arable land and meadow land lie either in closes or in strips intermixed with small common fields and are typically separated by a stock-proof boundary (often termed a head-dyke) from an 'outfield' area of less productive common pasture, which can be subject to intermittent cultivation. Land use on the lower slopes and on the valley floor is dominated by improved permanent grassland which forms the basis for systems of livestock farming combining both cattle and sheep. Livestock are only permitted into the 'infield' area after the harvest of hay and crops, their manure serving to fertilise the land. Walled tracks lead from the valley farms and settlements to the open moors, which are allotted to individual townships and communally managed to prevent overgrazing and the encroachments of individual ownership onto common land. Livestock are moved up and down the valley sides at different times of year: flocks of sheep grazed on the hill tops in summer and are brought down to the sheltered valley bottoms in winter and for lambing in the spring; cattle were over-wintered on the valley bottom and slopes or indoors and are moved onto the hills in the late spring (English Heritage, 2006). The type of farming system in place can often be identified through field names as they are sometimes related to use of the field e.g., Cow pasture, Milking field, Corn close, Lime kiln field and Lear field (Lear is another word for a scythe). They can also be descriptive of the place, including words like Holm (the land in a river bend, or low-lying land by the river), Syke (stream), Sievey (rushy), Heights, Stoney, Loaning (lane) or Thwaite (clearing). Other names refer to the vegetation; Birk (birch), Hollin (holly), Eller (alder), Broom, Brier. Sometimes the names reference annoying insects often found in hollows – Loppy hole (Lop was an old word for a flea, but maybe in this case meant ticks) and Midge hole (Bending, 2018).

Like Wales, the NYM has seen a reduction in cattle numbers and an increase in sheep numbers (Table 2.8). The dairy herd has reduced by 10% and the beef herd by 11% whilst the number of breeding ewes have increased by 10%. However, an increase in the total number of pigs by 37%, total fowls by 18% (although total poultry numbers have reduced by 9%) and goats by 17% indicates that there may be more options to change farming practice in the NYMs than in the uplands of Wales. The pattern of rearing traditional sheep breeds such as Swaledale, Wensleydale, Blackface, Texel and Dalesbred on the lush pastoral grasslands of the Yorkshire Dales and the North York Moors produces excellent lamb (NYMTN, 2020). These sheep are hardy and easily hefted, so good on northern hills. Mixing sheep breeds to develop sheep that best suit local conditions and to accentuate their best commercial features is an ongoing endeavour amongst sheep farmers. A mule is a cross breed sheep, mixing the qualities of hardier sheep with a more commercial breed either for wool or for meat (NYMNPA, 2018). A tup is another name for a ram, a wether is a castrated male lamb, a hog is an older lamb more than a year old, a gimmer is an older lamb which will be used for breeding (NYMNPA, 2018).

Table 2.8. Livestock numbers in the North York Moors for the years 2009/10, 2013 and 2016 by type and category.

Livestock type	Category	2009	2010	2013	2016
Cattle	Dairy herd[(a)]	8,978	8,789	7,464	7,146
	Beef herd[(b)]	11,936	12,124	10,893	10,602
	Calves <1yr	18,568	16,051	16,680	16,837
	Other cattle	20,541	22,792	19,480	19,424
	Total cattle	60,023	59,755	54,517	54,009
Pigs	Breeding herd	2,431	2,675	3,408	3,726
	Other pigs	47,452	54,620	72,007	75,699
	Total pigs	49,883	57,295	75,416	79,425
Sheep	Breeding ewes	126,493	123,901	136,696	140,171
	Lambs under 1yr	144,664	141,319	144,438	150,545
	Other sheep	10,313	9,134	6,556	5,404
	Total sheep	281,470	274,354	287,689	296,120
Poultry	Total fowls	274,555	297,800	238,757	334,949
	Other poultry	100,094	111,466	18,312	6,547
	Total poultry	374,649	409,266	257,070	341,496
Other livestock	Goats	216	261	426	345
	Horses	1,298	1,243	1,171	1,237

(a) Cows in the Dairy herd are defined as female dairy cows over 2 years old with offspring.

(b) Cows in the Beef herd are defined as female beef cows over 2 years old with offspring.

Source: Defra (2021).

Many farmers in the NYMs rear traditional cattle breeds such as Dexter and Belted Galloway, while Northern Dairy Shorthorn is another traditional cattle breed which can provide both meat and milk for cheese (NYMTN, 2020). In some areas, Highland Cattle are used for conservation. They are particularly hardy, extremely placid and are ideal for removing long, coarse vegetation, trampling the vegetation, creating pathways through the bracken and scrub and through dunging, returning nutrient back to the soil whilst also providing a food source for invertebrates (NYMNPA, 2016).

2.1.4.4. The farm business

The total rented land (35,855 ha) and owner-occupied land areas (43,594 ha) in the NYM are similar in area and proportion. Although both figures are similar there is a slight reduction in rented land within the park and a minor increase in owned land suggesting some farmers have bought previously rented or tenanted land. Those renting land within the NYMs are likely to be doing so by means of Agricultural Holdings Act tenancies (AHA) or Farm Business Tenancies (FBT). A large area of land rented within the North York Moors is rented from the relatively small number of large estates that exist within the park. The small increase in land ownership within the park is likely due to several larger farmers investing in their business with a view to benefitting from economies of scale (Hildreth, 2018). The average age of an LFA farmer in England is 61, which is the same as Wales (Harvey and Scott, 2020). Defra (2012) found that for 41% of upland farms, succession is secured (almost entirely within the family), lower than in Wales (WRO, 2010). For 25% there are no succession arrangements mainly because of no family or the family are not interested. For 34% of upland farms, succession is uncertain. Findings are similar to the 2009 Upland Farm Survey.

Table 2.9 (Defra, 2020a) shows the average farm incomes by farm type and cost code for England. The grazing livestock sector (LFA and lowland) and mixed farm types are all shown to be making a loss from agriculture and all three farm types are likely to struggle financially without BPS support. A significant percentage LFA grazing holdings farm income is support payments be they BPS or agri-environment and, due to the relatively poor profitability derived from farming in the uplands, the money received from these support payments equates to a large percentage of overall output (Hildreth, 2018). For many farmers in upland areas like the NYMs AES have been of great support to traditional agriculture in landscapes typically less conducive to food production. Looking at those farm types most commonly represented in the NYMs, agri-environment support on SDA grazing livestock farms makes up a higher percentage of total output than any other farm type (Hildreth, 2018). Within the NYMNP the percentage of farms with diversified income is less than the national average. From recent FBS figures 53% of farms within the NYMNP have some form of diversified income though these figures are derived from a small sample base. Although over half of farmers within the park have a source of diversified income for some it is likely to be a small income generator in comparison to the farm enterprise whereas for others it is likely to be a larger contributor to the overall farm business income (Hildreth, 2018).

Table 2.9. Farm Business Income by Farm Type and Cost Centre, England, 2019/20. (£ per farm). [(a)]

Farm Type	Agriculture	Agri-environment payments	Diversified income	Basic Payment Scheme	Farm business income
Cereals	800	4,400	19,600	38,100	62,800
General cropping	16,100	5,900	19,000	43,400	84,400
Dairy	43,200	4,100	7,400	30,100	84,800
Grazing livestock (Lowland)	-16,300	3,900	5,900	15,800	9,400
Grazing livestock (LFA)	-16,600	11,300	2,600	25,500	22,800
Specialist pigs [(b)]	15,000	2,600	6,600	13,500	37,700
Specialist poultry [(b)]	44,900	2,000	30,700	10,300	87,900
Mixed	-29,000	7,000	18,200	32,700	28,900
Horticulture	18,600	1,000	18,800	4,000	42,400
All types	-100	5,300	13,000	27,800	46,000

(a) Figures may not appear to add to totals due to rounding

(b) The sample sizes for specialist pig and poultry farms are relatively small with average incomes subject to greater variation.

Source: Defra (2020).

In summary, there are both similarities and differences between the uplands of Wales and the NYM's. LFA beef and sheep farms are the predominant farm type, however, in recent years, the number of beef cattle has been reducing in both areas. The grazing livestock sector is heavily reliant on BPS support payments and farmers in both areas are likely to have to make changes to farming practice if they are to survive. In the NYM there has been an increase in pig, poultry and goat farming, all of which bring higher profits from small areas of land. This shift in farming practice may be an indicator that there are options open to farmers in the NYMs. The landscape of Wales is harsher than that of the NYMs and this is likely to limit the farmers ability to move into these sectors.

As we move towards a greener agricultural policy with an increased emphasis on providing environmental goods will potentially be an increase in environmental payments though this will likely reduce the food production potential of the UK farmed landscape (Hildreth, 2018). Areas best placed to deliver public goods, such as the uplands, will likely see reductions in stock numbers, with some farmers already preparing for reducing stock numbers and managing grazing more carefully. It is likely than some LFA grazing livestock farmers in both the NYM and Wales will become financially unviable, and this may see the continued reduction in the number of small to medium size farms and an increase in the number of large farms as farmers seek to secure farm viability through economies of scale. Larger farms mean there are less people managing the land and this may see the need for increased cooperation between farms, especially if they wish to access funding through cooperative, landscape level AES.

2.1.5. Co-operation in the uplands

There has been a strong tradition of co-operation in the uplands as a result of the difficulties of terrain, weather and heft size. However, certain co-operative activities are decreasing including: participation by farmers in the local community, harvest activities such as hay-making and silage making, shearing and fell gathering, the gathering of sheep for activities such as such as lambing and shearing (Burton et al., 2005). In other areas such as tourist provision, there have been chances to increase levels of co-operation (Burton et al., 2005). Commercial farming in the uplands has been under sustained economic pressure for many years, characterised by consistently low levels of profitability and a high dependency on agricultural and environmental payments (Gaskell et al., 2010). There is widespread evidence the upland farmed landscape is changing at the national, regional and local levels (Gaskell et al., 2010; Lobley and Butler, 2010; Barnes et al., 2020). Upland habitats across Europe are all experiencing the same problem; the number of farming families managing the landscape is in decline (Burton, 2018). This decline has led to a transformation in the character and social structure of villages and rural communities. An increase in commuter transport, access to online services enabling work from home businesses and the availability of country properties, has led to an influx of newcomers seeking the 'rural idyll' (Mingay, 2017). These changes can create tension and divide as 'traditional' inhabitants find themselves outnumbered and outpriced by middle-class commuters and second homeowners. The introduction of the Agriculture Act 2020 (Defra, 2020c) will see the agricultural industry facing its biggest policy shake-up since the UK joined the Common Agricultural Policy (CAP) in 1973. There are concerns that these changes to agricultural policy will have an economic impact on upland farming (Dwyer, 2018; Liddon et al., 2019; Ojo et al., 2020) and further damage the contribution that the farming industry makes to social networks, social capacity, community resilience and other aspects of social and cultural capital in rural areas (Hill and Bradley, 2019). The next section will look at how this policy change will impact on the economic, social sustainability and environmental sustainability of farming in the uplands.

2.2. Economic sustainability

2.2.1. Agricultural Policy

Launched in the EU in 1962 and introduced to the UK in 1973, the CAP is a common policy for all EU countries. Managed and funded at European level from the resources of the EU's budget its primary aims are:

- To increase agricultural productivity by promoting technical progress and ensuring the optimum use of the factors of production, in particular labour.
- To ensure a fair standard of living for farmers.
- To stabilise markets.
- To ensure the availability of supplies.
- To ensure reasonable prices for consumers (European Union, 2020).

Constantly evolving, it has transitioned through three main phases in its quest to improve productivity (European Union, 2012) and create a better standard of living for the farming community (Van Zanten et al., 2014):

1. It moved Europe from food shortage to food plenty.
2. It changed and adapted to meet challenges linked to sustainability and the environment.
3. It expanded the role of farmers in rural development beyond just food production.

The move from shortage to plenty led to the ‘crisis years’ of the 1970’s and 1980’s where the EU brimmed with almost permanent surpluses of all farming commodities. In achieving self-sufficiency, negative externalities such as high budgetary costs, distortion of world markets and rises in negative perceptions amongst consumers and taxpayers appeared (EC, 2015). The MacSharry reform (1992) aimed to stabilise markets and reduce ‘Food Mountains’ by shifting product support to producer support (Daugbjerg and Swinbank, 2007). In 2000, further reform introduced cross-compliance and added a second pillar to the CAP focusing on rural development and the environment. In 2011, new proposals implemented a ‘greening’ element with 30% of the BPS requiring farmers to comply with new criteria. However, the European Court of Auditors (2017), found that greening is unlikely to provide significant benefits for the environment and climate, mainly because of the significant deadweight effect which affects the policy i.e., the subsidised activity or project would have been wholly or partly undertaken without public aid. They estimated that greening led to changes in farming practices on only around 5 % of all EU farmland. If the UK is to meet its climate change targets then a shift away from the CAP towards a policy developed to provide ‘public money for public goods’ should be welcomed (Bateman and Balmford, 2018). The public goods concept is well established in economic theory which defines public goods by the following characteristics (Cooper et al., 2009):

- Non-excludable – if the good is available to one person, others cannot be excluded from the benefits it confers.
- Non-rival – if the good is consumed by one person it does not reduce the amount available to others.

There is a wide range of public goods associated with agriculture - such as agricultural landscapes, farmland biodiversity, water quality, water availability, soil functionality, climate stability (greenhouse gas emissions), climate stability (carbon storage), air quality, resilience to flooding and fire – as well as a diverse suite of more social public goods, including food security, rural vitality and farm animal welfare and health (Cooper et al., 2009).

However, Agriculture has also been linked to a decline in the provision of public goods. Post-World War 2, farming practices became increasingly intensive in a bid to make the UK self-sufficient in food (Bowers, 1985; Robinson and Sutherland, 2002; Van Zanten et al., 2014). These levels of intensification continued post-1973 when production support provided by the CAP, became the major incentive for intensification of agriculture (Donald et al., 2002; Van Zanten et al., 2014). The intensification of agriculture significantly changed the structure of the industry. Between 1945 and 2002, there was a 65% decline in the number of farms and a 77% decline in farm labour (Robinson and Sutherland, 2002). Crop yields increased (almost fourfold; Robinson and Sutherland, 2002) but an estimated 97 % of enclosed grasslands were lost between 1930 and 1984 as a result of land consolidation or through conversion to arable land (UK National Ecosystem Assessment, 2014). Farms became more specialised and the use of machinery made operations quicker and more efficient, but this led to a 50% decrease in hedgerow stock (Robinson and Sutherland, 2002). By the mid-1980's, this production-focused approach meant farms had become so productive that they grew more food than needed, leading to surplus output being stored in 'butter mountains' and 'wine lanes' (Corron et al., 2007). Under the CAP, British farmland birds have declined by 56% (Harris et al., 2017), farming has contributed to around 60% of nitrate pollution in UK water ways (Holden et al., 2017) and agricultural intensification has been the primary driver of habitat destruction and species loss (Mitchell, 2017). Direct Payments, paid per hectare of agricultural land, have been seen to distort land prices, rents and other aspects of the market. A reliance on these payments, can foster inefficiencies which can limit the farmer's ability to improve the profitability of their businesses (Defra, 2018a). Leaving the EU gives the UK government and the devolved nations a once-in-a-generation opportunity to reform agriculture.

2.2.2. Post-Brexit Agricultural Policy

Following the 2016 vote to leave the EU, the UK government and the devolved nations entered a consultation period to assist in determining the future of agricultural policy post-Brexit. In England, 'Health and Harmony' (Defra, 2018a) outlined how the UK government plans to change the way land is used, so as better to promote health and harmony. At first glance, the consultation paper supports a truly green, productive, and holistic agricultural policy that provides value for money and promotes economically viable farming (Petetin and Dobbs, 2018). However, on closer inspection there is a lack of detail and assumptions in some areas, that will need further clarification if the policy is to be successfully implemented. Productivity gains are expected to reduce the need for state intervention, in the form of direct payments, with a greater reliance on market mechanisms (Cardwell and Smith, 2018). However, future trade agreements are unclear and UK farmers will have to compete in world markets (Petetin and Dobbs, 2018) where there is every likelihood EU farmers will continue to enjoy a level of area-based payments (Cardwell and Smith, 2018), Given the dependence of many UK farms on direct payments, their removal is likely to see many beef and sheep farms struggling to survive, as they tend to be much more reliant on direct support (Dwyer, 2018; Hubbard et al., 2018). Profitability groups are defined by lining up farms in order of profitability from 1-100 (with 1st position being least profitable and 100th position being most profitable) and dividing these up into 10 groups (Defra; 2018e), Based on profitability, it is estimated that on average, the bottom 10% (65% of which are grazing livestock or mixed farms) need to reduce inputs costs by 31% in order to break even (Defra, 2018b). Leaving the EU will significantly affect the financial viability of a large proportion of upland farms, resulting in land use change affecting most of the country (Dwyer, 2018; Barnes et al., 2020; Manzoor et al., 2021) e.g., sheep farming in the UK without subsidies is only profitable if farmer and spouse labour are unpaid, even then, only the most productive farms break even (O'Neill et al., 2020). Defra accepts that proposed policy changes will accelerate structural change, increase the rate at which farms cease trading and release land to the market (Defra, 2018b; Franks et al., 2019).

In Wales, the primary focus of this study, an initial consultation, 'Brexit and our Land' (WG, 2018) received over 12,000 responses which led to the Welsh Government revising its proposals and issuing a second consultation document 'Sustainable Farming and our Land' (WG, 2019b). Both the UK and Welsh Governments support replacing the current payment system with a sustainable, outcome-based, land management approach which will pay farmers 'public money for public goods' (Defra, 2018a, WG, 2019b). This move towards a sustainable land management system may provide a lifeline to upland farmers facing hardships following direct subsidy removal (Barnes et al., 2020) but payments will need to be enough to support and enable a move towards more extensive farming practices.

The removal of direct support payments will not be immediate. Following a departure from the EU the UK will enter a transition period, which for England is the period of seven years starting from 2021 (Defra, 2020d; UK Parliament, 2020). The Welsh Government is likely to implement a similar transition period following further funding information and the introduction of an Agriculture (Wales) Bill (WG, 2019b). As part of the transition to a new agriculture policy Defra (2020):

- plan to ‘delink’ Direct Payments from the land for all farmers.
- will look to offer farmers a one-off optional lump sum payment in place of direct payments.

Delinking means that recipients will no longer have to farm in order to receive payments during the agricultural transition. It will give farmers an opportunity to invest in their business to boost productivity and profitability or diversify their activities. Some farmers may decide to stop farming altogether and use the payment to contribute to their retirement or move to another sector. The aim, by the end of the transition period, is to have a renewed agricultural sector, producing healthy food for consumption at home and abroad, where farms can be profitable and economically sustainable without subsidy support (Defra, 2020d).

In the past, poor communication between government agencies and farmers, and problems with way in which schemes have been designed and administered, has caused difficulties for farmers (Defra, 2020d). Throughout the transition period a variety of schemes will be introduced which will pay for environmental and animal welfare outcomes, offer a range of grant options which will help farmers invest in productivity measures and provide support to new businesses through innovation, efficiency and business support tools aimed at helping farmers improve farm resilience (Defra, 2020e). Farmers will have to make decisions which may see them having to significant change farming practice if they are to remain profitable after the abolition of CAP payments (Petetin and Dobbs, 2018). It is vitally important that previously poor communication channels are improved to enable policy plans to be effectively transmitted to the farmer. This will give them the time needed to prepare for the upcoming changes that will see them move to a ‘public money for public goods’ approach to land management (Petetin and Dobbs, 2018). The concept of paying farmers and land managers to provide ecosystem services (public goods) is not new. Agri-environment (AES) and Payment for Ecosystem Services (PES) schemes which pay farmers who choose to adopt specific environmental management practices e.g., the protection or enhancement of biodiversity, soil, water, landscape, or air quality, or climate change mitigation or adaptation on their farms (Science for Environment Policy, 2017), are popular ways to manage ecosystems using economic incentives (Farley and Costanza, 2010).

2.2.3. Agri-environment and Payment for Ecosystem Services

PES concepts are broadly divided into two main approaches; one closely linked to the Coase Theorem and the other a Pigouvian type PES (Sattler and Matzdorf, 2013). The Coase Theorem is based on the assumption that, given certain conditions, the problems of external effects can be overcome through private negotiation directly between the affected parties regardless of the initial allocation of property rights (Engel et al., 2008). Wunder (2008) provides a widely accepted definition of PES which states they should contain the following elements:

- A voluntary transaction
- A well-defined environmental service or a land use likely to secure its provision
- At least one buyer
- At least one provider effectively controlling service provision
- If, and only if, the environmental service provider secures service provision

This definition has however been challenged for being too narrow as schemes which include government intervention and public payment schemes i.e. Pigovian type PES are excluded (Schomers and Matzdorf, 2013). Muradian et al. (2010) provide a broader definition, "Transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources".

An exploration of AES definitions finds similarities to those of PES. The European Council (2005) defines AES as "measures to provide payments to farmers who subscribe, on a voluntary basis, to environmental commitments related to the preservation of the environment and maintaining the countryside". Burrell (2012) describes AES as, "broadly involving payments to farmers in exchange for environmental goods and services such as biodiversity conservation". However, the true linkages between AES and true PES are challenged. Uthes and Matzdorf (2013) found AES objectives to be vague and lacking in quantifiable indicators making it difficult to measure cost-effectiveness and ecological effectiveness. Wynne-Jones (2013a) argues that the Welsh agri-environment scheme is a hybrid model, rather than a pure PES scheme. Reed et al. (2014) argue that AES predominantly focus on the provision of income support and compensation for physical disadvantage rather than explicitly rewarding the provision of public goods and argue that the prescriptive nature of AES means that whilst the status quo is maintained, AES do not contribute significantly to improvements in biodiversity. The links between AES payments and ecosystem outcomes are not strong (Reed et al., 2014; MacDonald et al., 2019), indicating a need to assess opportunities and barriers to successful ecosystem service delivery through AES and PES separately.

2.2.4. Agri-environment Schemes

Global approaches to AES delivery vary. Baylis (2003), in a US/EU comparison, found both recognising AES as a "trade-friendly way to transfer income to farmers whilst appeasing a growing environmental lobby". Nevertheless, approaches to the interface between agricultural and environmental policy vary significantly between the two regions. The fundamental difference between the two approaches is that of 'Land Sparing', the US approach vs. 'Land Sharing', the EU approach. Land sharing involves integrating biodiversity conservation and food production on the same land, using wildlife-friendly farming methods whilst land sparing consists of separating land for conservation from land for crops, with high-yield farming facilitating the protection of remaining natural habitats from agricultural expansion (Phalan et al., 2011; Phalan, 2018). Baylis (2003) argues that in the US the highest environmental value is gained by taking land out of farming and returning it to its natural state. Whereas in the EU, agricultural and the environment are complimentary with farming seen as having the highest environmental value. Some Australian agri-environment schemes also choose a land sparing approach (Fischer et al., 2008; Fischer et al., 2010). Direct evidence showing the effectiveness of the US and Australian agri-environment schemes is relatively scarce (Batary et al., 2015) but research points to land sparing as the more effective approach for biodiversity and GHG reduction (Phalan et al., 2011; Tanentzap et al., 2015; Lamb et al., 2016; Cannon et al., 2019; Feniuk et al., 2019). Tscharntke et al. (2012) argue that whilst land sparing may appear to be the most effective approach, its implementation is not so simple as real-life complexities must be considered. Land sharing schemes, whilst reportedly not so effective, take into account the socioeconomic needs of the communities in which they are applied (Mills, 2012; Grass et al., 2019).

AES programming and management is complex with often imprecise objectives. They employ multiple measures, to achieve multiple objectives, in an often fragmented data landscape in which to measure outcomes (Uthes and Matzdorf, 2013). This complexity shaped the structure of European AES into one of ‘action-based’ payments, that is, paying farmers to deliver management practices rather than deliver environmental outcomes. This type of scheme is easy to manage and more readily accepted by farmers due to minimal changes to existing practice (Burton and Schwarz, 2013). However, the effectiveness of these ‘action-based’ schemes in increasing biodiversity and reversing species decline has been challenged (Smart et al., 2013; Besnard and Secondi, 2014; Batary et al., 2015). Some suggest moving to a results-based approach would be more efficient and cost-effective (Burton and Schwarz, 2013; Schroeder et al., 2013; Reed et al., 2014; de Sainte Marie, 2014; Chaplin et al., 2019). The results of a Results Based Agri-Environment Payment Scheme (RBAPS), developed as a pilot in England from 2016 to 2018, has shown that "a pure results-based approach provides an important motivation, and also a value-for-money safeguard to ensure payments are only made for performance above a defined minimum level" (Chaplin et al., 2019). The results also make it clear that "the results-based approach has considerable potential to improve the performance of agri-environmental measures, and early indications suggest that delivery costs and scheme payments are unlikely to be significantly different to those of management-based measures, suggesting that the approach could deliver some efficiency gains" (Chaplin et al., 2019). One factor potentially influencing the options vs. results-based debate is the percentage of land involved in agriculture at a national level. The US with 44.6% land in agriculture and Australia with 52.9% land in agriculture err towards a land sparing approach whilst the UK with 71.2% has a land sharing approach (World Bank, 2014). However, in England, since the introduction of the Countryside Stewardship Scheme (CSS), the total number of agri-environment agreements (entry and higher level) has fallen from 46,500, covering ~7.7 million hectares of agricultural land in 2014 to 32,500, covering ~3.7 million hectares in 2018.

Decisions are also influenced by the fact that, politically, not all AES objectives will be environmental. As part of National Rural Development Plans they have a role to play in the provision of social benefits (Mills, 2012), a role more important in a high agricultural density landscape such as the UK. The convoluted nature of the agri-environment landscape makes quantifying effectiveness difficult. Perceptions of success are shaped by desired outcomes. Campaigners such as Monbiot (2013) would see a total land sparing approach employed to allow 'rewilding' and therefore measures success on the quantity of land withdrawn from agriculture. This rewilding approach advocates the restoration of species and processes removed by human actions, which can require reductions, or total removal, of agricultural and other primary resource-use activities (e.g., hunting; Wynne-Jones et al., 2018). This inevitably causes conflict with the people who value these activities and landforms (Lorimer et al. 2015; Navarro and Pereira 2015). Rewilders are also critiqued for downplaying or obscuring the human history of an area, and the heritage value of activities which have shaped current landscape forms (Convery and Dutson 2008; Drenthen 2009; Wynne-Jones et al., 2018).

In contrast, organisations such as the RSPB (2009) and PONT (2017) recognise that the uplands are special places. unique cultural landscapes shaped by centuries of human activity and pastoral farming systems (Defra, 2013), and advocate the use of grazing as a tool to increase biodiversity in plant species and to create habitats for ground nesting bird populations and ultimately require agriculture to achieve these objectives. Mills et al. (2010), whilst not directly measuring the success of AES on a social scale, highlight the benefits to the wider economy and society beyond the scheme's original remit.

The argument is further complicated by CAP and WTO rules which state AES payments are made on the basis of income foregone i.e. "The amount of payment shall be limited to the extra costs or loss of income involved in complying with the government programme." (GATT, 1994; Ovenden et al., 2010; European Commission, 2013; Burton and Schwarz, 2013; Gravey et al., 2017). If future agricultural policy is constrained by factors such as income foregone, there is a risk that small scale, upland farming struggling with viability and forced to reduce stock, will become be ineligible for AES payments that could enhance their economic sustainability (Environmental Audit Committee, 2016; Gravey et al., 2017). In a recent lecture at the Oxford Farming Conference Geraghty (2017) quoted a Brazilian farmer as saying, "Farmers in the red cannot look after the green", a serious concern should subsidies, and therefore farm income, reduce. Future policy should have sufficient flexibility to be sensitive to local economic, environmental and geographic conditions and should ensure that public money really does deliver public goods (Gravey et al., 2017) and contribute to the overall sustainability of the uplands. Policy makers will have to react to changes in trade deal structure and farming practice if environmental practices and targets are to be sustained. Should farm profitability fall, PES may well become the preferred option over AES, because PES compensatory payments are not constrained by WTO rules (Franks, 2016).

2.8.1. Payment for Ecosystem Services

Although the ecosystem services concept originated in the late 1970's (Gómez-Baggethun et al., 2010) it was not until the Millennium Ecosystem Assessment (MEA; 2005) that ecosystem services became mainstream in policy. Following this highly influential assessment, literature surrounding ecosystems, and the delivery of ecosystem services, has grown exponentially (Fisher et al., 2009). The MEA (2005) framework encompasses a comprehensive analytical and practical process to identify services and assess the socio-economic, political and cultural benefits to human well-being. The chosen ecosystem and services are then modelled, mapped and valued (Turner and Daily, 2008). Since its introduction, PES schemes have become increasingly more popular in attempts to internalise environmental externalities through the creation of markets and quasi-markets (Farley and Costanza, 2010; Van Hecken and Bastiaensen, 2010; Schomers and Matzdorf, 2013; Jost and Gentes in Pretzsch, et al., 2014; Bellver-Domingo et al., 2016). They are not, however, a "silver bullet" (Engel et al., 2008), there is no "one size, fits all" arrangement to ensure the successful implementation of a PES scheme (Kemkes et al., 2010; Förster et al., 2019). PES schemes reportedly form part of a market-based instruments (MBI) toolbox, which also includes pollution taxes, cap and trade schemes and eco-certification and labelling. This toolbox is designed to provide the policy-maker with options to deliver 'economically efficient and targeted' market-based solutions to environmental policy problems (Lockie, 2013). Potter and Wolf (2014) challenge the market-based concept showing current PES "experiments" to be predominantly state-sponsored enterprises structured around agri-environment principles of voluntarism, standardised incentive payments and solidarity between farmers and public agencies. Schomers and

Matzdorf (2013) include government payment programmes in a discussion on PES but see these Pigouvian style schemes being marketed under the PES label rather than being true PES. In reality, the PES framework is seen by some as fragmented, with many schemes being small scale pilot schemes brokered by the state, or NGOs with self-driven interests (Potter and Wolf, 2014). Complexities surrounding the social interaction between buyer and seller mean that few are 'true' PES schemes (Muradian et al., 2010). In the UK, there are several examples of government agencies, NGOs and the private sector, coming together (Cleasby, 2009; Defra, 2016) to deliver ecosystem services through a combination of conventional AES and PES e.g.

- Wild Ennerdale: A project based on principles rather than targets, experimental in nature and without defined outputs to allow natural processes and extensive systems of land management to govern activity in a Lake District valley.

and

- The Sustainable Catchment Management Project (SCaMP): An uplands land management project targeted on farmers and designed to deliver environmental, biodiversity and water quality benefits by using private funding to lever in additional public funding.

These schemes can produce successful outcomes but there are often significant barriers and challenges to continued success including, time and resources required to build trusted relationships and stakeholder buy-in, the need to develop new legal and institutional structures to facilitate PES arrangements and issues relating to long-term funding (Cleasby, 2009; Defra, 2016). Results-based PES are WTO-compliant and this could make them an attractive option to the policymaker looking to replace current options-based agri-environment schemes (Hasund and Johansson, 2016), but an understanding of the socio-cultural landscape into which they would be placed is vital for success. Farmers and foresters tend to gain few private benefits from employing environmentally friendly land sparing approaches in lieu of ecologically destructive cropland or pasture (Van Hecken and Bastiaensen, 2010). This forces the policymaker to select an approach, should they focus on negative externalities and employ a 'polluter pays' approach or should they focus on the positive externalities and regard farmers and landowners as potential or unrecognised ecosystem services providers. PES relies on a positive externalities approach or beneficiary-pays principle (BPP) (Van Hecken and Bastiaensen, 2010) which is, in itself, challenged by some as being an indefensible approach (Huseby, 2013). Despite these challenges most researchers agree that PES has some role to play in encouraging landowners to manage their land for ES (Kemkes et al., 2010) but they must be targeted (Wendland et al., 2010) and should prioritise efforts on non-substitutable ecosystem services who's supply is insufficient to meet basic needs or are in imminent danger of becoming so (Farley and Costanza, 2010). Effective delivery of ecosystem services at a landscape level requires local knowledge and collaboration between farmers and other stakeholders (Vanni, 2013).

2.3. Social sustainability

2.3.1. Capitals (Social, Human and Cultural)

Social capital, the degree of social connectivity of a farmer, can have both positive and negative influences on a farmers decision to join an AES (Mathijs, 2003). Bourdieu's (1986) theory of capital, cited in de Krom (2017), identifies three forms of capital; economic capital (resources as material property), social capital (resources that can be mobilised via social connections and mutual obligations) and cultural capital (resources in the form of knowledge, skills, dispositions, and possession of culturally significant objects). It states that capital can shift between the three forms via symbolic capital (status and reputation). Burton and Paragahawewa (2011) expand on Bourdieu's theory, arguing that economic incentives whilst able to financially motivate behavioural change but they cannot replace the social and cultural capitals that are needed to develop the ethos, beliefs and knowledge required to implement change and underlie policy instruments. In traditional upland farming systems farmer numbers are dropping and, as numbers decline it becomes more important that people cooperate in order to maintain traditional practices. The importance of social capital is likely to increase, however, at the same time the mechanisms for generating the required social capital through co-operative actions are diminishing (Burton et al 2005). Further declines in farmer numbers will potentially push these upland systems to the point where they are no longer social and environmentally sustainable and this in turn will Preghiera impact upon future plans to deliver public goods on a landscape level (Burton et al, 2005). The economic impact of subsidy removal will potentially see a significant reduction in upland farmer numbers (Barnes et al., 2020) leading to further declines in the social sustainability of the uplands. In addition to food production, upland agriculture manages important natural resources and supports socio-economic development of rural areas (Terres et al., 2015). It is estimated that 50% of all plant and animal species (including some of that are listed in the EU Habitat Directive) depend on agricultural practices (Terres et al., 2015). A further decline in farmer numbers, and the associated reduction in sheep and cattle numbers, has the potential to see land abandonment. This could lead to higher deer numbers, increased rank vegetation, scrub and birch tree regeneration (and associated increased fire risks), declining farmland birds, decreases in rabbits and hares, increased ticks (and associated tick-borne disease), reduced wetland waders and a decrease in species diversity (Thompson et al., 2011). If future policy fails to deliver economic sustainability, the cultural capital and heritage of many upland landscapes will decline (Beilin et al., 2014; Molnár and Berkes, 2018).

The impact of social capital on farmer behaviour is further explored by Wynne-Jones (2013b) who found farmers not necessarily prioritising financial gain over other factors and that equal or greater utility may be gained from participation in actions which benefit the environment or society. Strong relationships and cultural bonds existing within the social landscape can enhance the likelihood of an individual joining AES or PES but they can also pressurise an individual to refrain, if their activities conflict with the cultural norms or expectations of their neighbours (Mathijs, 2003; Lastra-Bravo et al., 2015). Involvement in AES or PES, especially in higher level collaborative schemes, can clearly lead to the generation of social benefits through increased on-farm employment, stability of income, and human and social capital development (Mills, 2012). However, scheme design can hinder this capital generation. Prescription-based AES do not encourage farmers to develop, display and recognise cultural competences related to achieving environmental goals (Deuffic and Candau, 2006; de Krom, 2017). In these vertically organised AES, farmers will do nothing more than follow the standard rules (Deuffic and Candau, 2006) and public appreciation of farmer's environmental efforts are assumed rather than actively promoted. Therefore, the social capital that could be gained from non-farming members of society is missing (de Krom, 2017). The Pont Bren Project consists of a group of farmers who have overcome some of the social challenges facing farming communities by coming together to reduce costs, make their farming systems more economically and environmentally sustainable in the longer term, and improve prospects for the next generation on these family farms (Keenleyside, 2013; Wynne-Jones, 2017), Their innovative approach uses woodland management and tree planting to improve the efficiency of upland livestock farming (Keenleyside, 2013) and in doing so, they have been able to overcome the inflexibility of agri-environmental schemes available to them as individuals. The key factor in the success of Pontbren has been the farmers – collaborating as a group, cooperating with the scientists, but each remaining firmly in control of the management decisions on their own land (Keenleyside, 2013). The farmers at Pont Bren needed outside help with planning the new woodland and the details of woodland management, skills which most of them had not required before, but it is their own skill and knowledge that makes the project a success (Keenleyside, 2013).

Human capital refers to the knowledge, information, ideas, skills, and health of individuals (Becker, 2002). Human capital is imbedded in people, it grows through use and experience gained through employment and formal and informal learning, but it also tends to depreciate through lack of use (Healy and Côté, 2001). Coleman (1988) found social capital, both in the family and within the community, having a role to play in the development of human capital within the rising generation. Children learn from people around them, and the strength of the relationship between parent and child will determine the level of human capital passed between the two (Coleman, 1988). Outside of the home, people gather human capital through the education system, the workplace and through the groups to which the belong (Pretty and Ward, 2001). Informal learning and local knowledge gained through trial and error by people living and working areas, such as the uplands, is dynamic and constantly evolving as it must respond to changing conditions and external stimuli (Mansfield, 2018). The rural depopulation of traditional land management operatives (farmers and foresters), changing demographics within the community or a lack of access to external resources can undermine human capital as knowledge transmission diminishes and skills are lost (Mansfield, 2018). This in turn may directly impact on the natural capital within an area e.g., if a reduction in direct payments leads to a reduction in Welsh LFA grazing livestock farmers, as predicted (Dwyer, 2018), the potential consequences are that upland peatland/meadows and associated features are undermanaged; scrub spreads and some land is abandoned in the most inaccessible areas (Dwyer, 2018). All three of these capitals, human, social and natural, are interlinked, and a reduction in one will have a detrimental effect on the others, therefore if future policy aims to deliver public goods in the uplands of the UK it must also address issues impacting upon levels of social and human capital (Mansfield, 2018).

In addition to the above 'capitals' there is cultural capital which can be either tangible e.g., artworks and artefacts such as paintings and sculptures and heritage buildings or intangible e.g., the stock of inherited traditions, values, beliefs and so on which constitute the 'culture' of a group, whether the group is defined in national, regional, religious, ethnic or other terms (Throsby, 1999). For farmers, embodied cultural capital is constructed through the performance of everyday activities and is manifest primarily in the level of farming skill possessed by the farmer, creating the mythical, 'good farmer' principle (Burton et al., 2008). Cultural capital can present barriers to the uptake of environment schemes such as AES as they are often seen as being counter to the principles of good farming, which tend to have a production-based focus (Burton et al., 2008). If future schemes are to succeed, they must take into account the impact of varying capitals upon a community and 'recognise that farmers also need to preserve a way of life, a sense and a value for their professions', rather than challenging their 'professional identities' (Burgess et al. 2000).

2.3.2. Farmer and Public Perceptions of the Environment

Studies agree that most current, prescription-based, AES fail to create long term changes in farmers attitudes towards more environmentally friendly practices (Burton and Paragahawewa, 2011; Burton and Schwarz, 2013). Studies by Mills (2012) and Hyland et al. (2016) identify farmer types based on attitudes towards the environment and perceptions of climate change (Table 2.10).

Table 2.10. Farmer types and the main perception characteristics extracted from studies conducted by (Mills, 2012) and (Hyland, Jones, Parkhill, and Barnes, 2016). They describe perceptions towards environmental management and climate change.

Mills Farmer Type	Main Perception Characteristics	Hyland Farmer Type	Main Perception Characteristics

Willing and engaged only	A willingness to undertake environmental management activities within or outside AES. Not translated into behaviour because of a lack of ability to do so due to biophysical, skills, labour or financial constraints.	The Countryside Steward	A high sense of environmental responsibility and see themselves as protectors of the countryside. Low behavioural capacity to implement climate change mitigation measures due to a low sense of awareness and perceived risk associated with livestock management.
Able and engaged only	Undertaking environmental management and have engaged with advice but lacked sustained motivations to maximise environmental benefits. Environmental management viewed as a crop managed according to scheme prescriptions. Will undertake minimum environmental activity required for funding.	The Productivist	Have a low sense of environmental responsibility, whilst displaying a penchant for productivism. See their enterprise as a business focusing on the quantitative outputs of land management. Less aware than other groups of climate change and do not perceive it a risk. Low behavioural capacity to implement mitigation and adaption measures.
Willing and able only	Actively undertaking environmental management but have not engaged with advice meaning land not delivering full environmental potential. Not engaged in schemes due to a lack of confidence in AES prescriptions.	The Environmentalist	Highly aware of climate change and have a high sense of environmental responsibility. Both motivation and behavioural capacity to implement mitigation measures were high but a low sense of risk may create a lower likelihood of adopting adaption measures. Do not value the findings of scientists and researchers.
Disengaged	Have not engaged with any environmental management, either because they are not willing, have no capacity, dislike outside interference or are concerned about loss of control or management flexibility. Very difficult to influence their norms of self-identity.	The Dejected	Project a pessimistic and dejected disposition towards climate change as they expect it to affect them unfavourably. High sense of awareness and risk but a low sense of awareness on how GHGs are generated.

Understanding self-identity is fundamental in assessing farmer motivations for adopting environmental measures and for participation in AES/PES (Sulemana and James, 2014). Self-identity is likely to be the motivating factor in willingness of the 'Willing and able only' and 'Environmentalist' farmer types to adopt environmental practices without financial reward (Hyland et al., 2016). van Dijk et al. (2016) found self-identity to be the most important factor in a farmers' intention to perform unsubsidised agri-environment practices. Identity is personally constructed but it is often influenced by the social landscape in which an individual operates (Mills, 2012; Sulemana and James, 2014). It can therefore be altered over time if there is access to supportive, constructive interaction between farmers, nature conservation officers and the general public (Riley, 2016; Howley et al., 2014; Sulemana and James, 2014). Lastra-Bravo et al. (2015) found farms that involve a high proportion of family labour exhibiting a lower likelihood of participating in AES. Policies that reduce farm household's dependence on on-farm income could therefore have the externality benefit of bringing more farms into AESs. This study also found education, age and the presence of a successor to influence participation and farm size and levels of payment playing a significant role in accessing AES (Lastra-Bravo et al., 2015). Access to social capital (Mathijs, 2003), previous experience of AES (Lastra-Bravo et al., 2015) and attitudes to the environment (Hyland et al., 2016) are also key drivers in AES uptake.

Public perceptions of the environment and the role of farmers in landscape management are important factors to be considered by policy makers designing publicly funded schemes. Research conducted by Poortinga et al. (2011) found personal values to be a driver of climate scepticism with older individuals with politically conservative and traditional values and coming from lower socioeconomic communities being the most sceptical (Melorose et al., 2015). Similar demographics - political orientation, gender, economic background and age, have also been drivers of scepticism in the US (McCright, et al., 2016). General awareness of climate change amongst the general public appears to be widespread, but knowledge is predominately shaped by mass media rather than through access to scientific publications or direct involvement in science (Corbett, 2004; Poortinga et al., 2011; Happer and Philo, 2016). Despite scepticism in some areas there is evidence of support for subsidies amongst the general public in the US and Ireland with the main reasons for support being, food security, providing support to low income farmers and the preservation of farm landscapes and environmental benefits (Ellison et al., 2010; Howley et al., 2014). Farmers' ways of thinking and ways of farming are intrinsically linked (Vuillot et al., 2016) and explains why some farmers, for example organic farmers, will adopt alternative, environmentally friendly, farming methods (Casagrande et al., 2016).

2.3.3. Collaborative Action

Ecosystem services are interlinked and transboundary (Barker et al., 2010) and require management for supply to be coordinated across landscapes rather than at individual farm level (Goldman et al., 2007). AES have been traditionally, delivered at the scale of the individual but collaboration schemes are increasingly being introduced e.g., Pont Bren (Keenleyside, 2013); Glastir Commons (Reed et al., 2014) and Integrated Local Delivery and Dartmoor Farming Futures (Mills et al., 2012). They are also increasingly recognised as beneficial for successful agri-environmental management for the environmental benefits they can deliver across agricultural landscapes (Prager, 2015). The words coordination and collaboration are often used interchangeably but they differ in how they refer to work practices (Prager, 2015). Boulton et al. (2012) distinguishes between them, defining collaborative approaches as landowners meeting, working together and maintaining a dialogue. Coordination is defined as land managers working towards the same objectives but in isolation. The spectrum depicted in Fig. 2.6 shows examples from the study completed by Boulton et al. (2012). Coordinated and collaborative schemes can be driven by top-down or bottom-up approaches, but top-down, government-led schemes, are normally coordinated efforts rather than truly collaborative. If, as the literature suggests, schemes involving multiple actor cooperation bring increased socio-economic and environmental benefits (Mckenzie et al., 2013; Asai and Langer, 2014; Prager, 2015; Swagemakers et al., 2019), what are the barriers and opportunities for their adoption? In Denmark, organic farmers have been cooperating for over a decade to ensure compliance with mandatory environmental regulations (Asai and Langer, 2014). Approx. 70% of Danish organic dairy farmers collaborate with organic arable farms over nutrient transfer through the movement of manure (Asai et al., 2014).

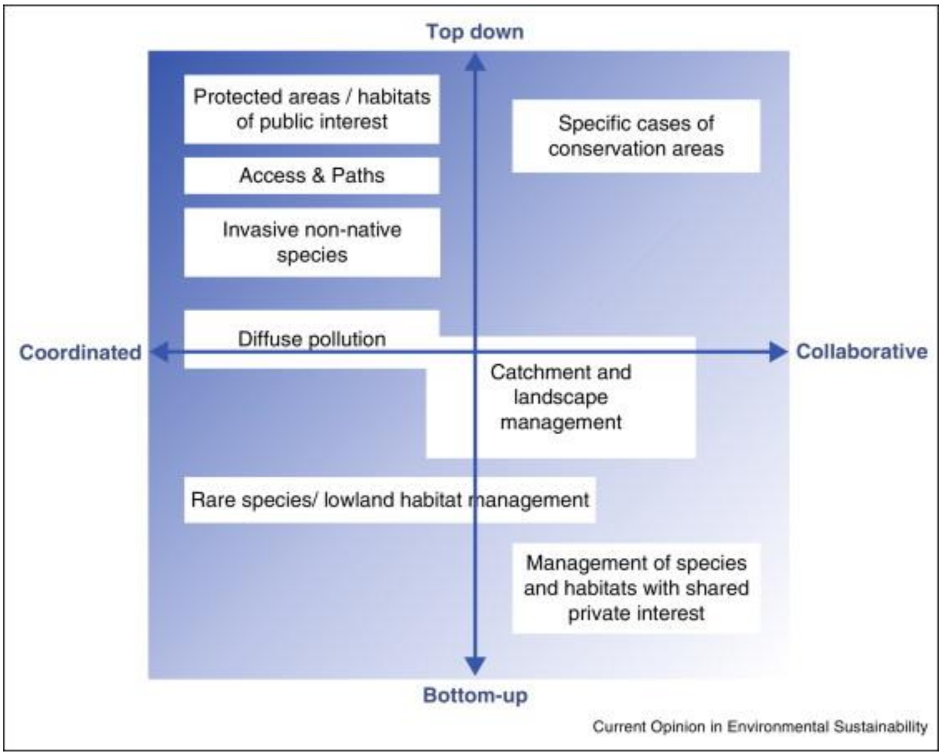


Figure 2.6. The coordination - collaboration spectrum incorporating a top down - bottom-up spectrum. Source: Boulton et al., (2012)[2].

Social connections, trust and reciprocal relationships built through high-quality communication and well-functioning arrangements have been key to the development of long-lasting, adaptable relationships capable of reacting to shifting global markets and tightening

[2] The darker blue indicates governance influence, the light blue local and regional schemes.

regulations (Asai and Langer, 2014). It is argued that schemes operating under the CAP are ineffective at biodiversity conservation and maintaining and enhancing species abundance, amongst other things, because poor design and implementation promotes fragmentation instead of collaboration (Emery and Franks, 2012; Leventon et al., 2017; MacDonald et al., 2019).

Actively managed communication horizontally and vertically appears as a key theme for success throughout the literature (Emery and Franks, 2012; Prager, 2015; Opdam et al., 2016), but communication alone is not sufficient to encourage participation. Current practice and the design of collaborative AES or PES schemes have an influence of farmer willingness to participate (Prager, 2015). Emery and Franks (2012) identified several key opportunities and barriers to uptake:

1. Farmers in higher tier AESs (Countryside Stewardship and Higher-Level Stewardship) are more willing to work with other farmers on collaborative AES than farmers in lower tier schemes and non-AES participants.
2. Collaborative AES are likely to be more successful where: they do not require the whole farm to be entered into a scheme; farmers are involved in scheme design; the scheme is flexible in initial design and adaptable to changing circumstances; they are locally specific with clear aims; they work towards clearly demonstrable benefits with monitoring and reporting to that end, and they are seen to reduce rather than increase risk.
3. Eighty percent of farmers thought schemes would be better overseen by an external agency, 50% thought this should be by government, 50% by an NGO.

The concept of a successful collaborative scheme involving part farm involvement is challenged by Burton and Paragahawewa (2011) who state this, “Allows farmers to disown responsibility for scheme areas to concentrate on the productive side of the farm”. Literature clearly shows benefits to both collaborative and coordinated AES or PES schemes but farmers need to see benefits and scheme detail would be an important consideration in participation decisions (Mckenzie et al., 2013). It is argued that a complete rethink on PES is needed to encourage collaboration (Prager, 2015) and that on a grander scale, there is a need for a social contract between farmers and society if provisioning goods are to be supplied in an environmentally friendly way (Allen and Hart, 2013). Goldman et al. (2007) suggest the need for contrasting approaches, which account for the socio-cultural dynamics of the targeted landscape. The success of any scheme design will therefore involve a clear understanding of the social, cultural, human and symbolic capitals (van Dijk et al., 2015). These capitals could potentially be generated through involvement in collaborative schemes.

2.4. Environment sustainability

2.4.1. Environmental and Sustainable Development Policy

Currently, responsibility for UK environmental, agricultural and sustainable development policy is apportioned to devolved administrations (National Assembly of Wales, 2006). Each of these has its own political agenda - in Wales it is, ‘to meet the needs of the people of Wales’. The outcomes of ‘The Wales We Want’ consultation informed policy makers developing sustainable development strategy and led to the release of the 'Deddf Llesiant Cenedlaethau ’ r Dyfodol, Well-being of Future Generations (Wales) Act 2015’ (Davies, 2016). This policy, whilst acknowledging Agenda 2030 (DiFD, 2017), does not mirror the UN’s sustainable development goals (SDGs). Agenda 2030 has 17 SDGs whilst the Future Generations Act has 7 well-being goals and 46 indicators. The Welsh government will, “take account of any action taken by the UN in relation to the SDGs and assess the potential impact of that action on the economic, social, environmental and cultural well-being of Wales” but will only act if it impacts Wales, confirming their priorities to act nationally.

In addition to sustainable development policy, the UK government has instigated the Environment Bill 2019-20 (UK Parliament, 2019), which aims to maintain and improve environmental protections as the UK leaves the EU. This bill builds on the government's strategy to protect the environment, as set out in their 25 Year Environment Plan (HM Government, 2018). Further legislation to reach net-zero carbon emissions by 2050 (CCC, 2019) and a plan to host the climate-focussed COP 26 in 2021 aims to keep the UK at the forefront of international work on these issues. While the bill applies only to England, more than half of its measures - such as those designed to drive up recycling rates - are designed to apply across the UK, with the consent of devolved administrations. In Wales, the Environment (Wales) Act 2016 (WG, 2016) aims to promote the sustainable management of natural resources whilst 'Prosperity for All: A Low Carbon Wales' (WG, 2019c) delivers a strategy to cut emissions and increase efficiency in a way that maximises wider benefits for Wales. The Committee for Climate Change (CCC; 2019) recognises that Wales has less opportunity for CO_2 storage and relatively high agricultural emissions that are hard to reduce. On current understanding it could not credibly reach net-zero GHGs by 2050. It therefore recommends that Wales should set a target for a 95% reduction in emissions by 2050 relative to 1990. If the UK and Wales are to realistically reach climate change targets by 2050, then agricultural policy will have a major role to play in shaping the future of agricultural practices post-EU departure. The Welsh government will deliver on its well-being and climate change goals through its Natural Resources Policy (WG, 2017) which aims to build greater resilience into the ecosystems that deliver multiple benefits to the economy, society and the environment.

2.5. The Ecosystem Services Approach to Land Management

The onset of the industrial revolution and changes to agricultural policy over the last 200 years significantly advanced the rate of decline of the planet's ecosystems (McLamb, 2011; Van Zanten et al., 2014; Robinson, 2016). Agriculture, industry, recreation and international commerce are so far reaching that no ecosystem is free from the effects of human influence (Vitousek et al, 1997; Chae and An, 2018; Grenni et al., 2018; He and Silliman, 2019). Statistics demonstrate that the abundance and distribution of the UK's species has, on average, declined since 1970 and many metrics suggest this decline has continued in the most recent decade (Hayhow et al., 2019). In Wales, the State of Nature report (State of Nature Partnership, 2019) report shows that, on average, Wales' wildlife has declined in recent decades and species distribution, which covers a broad range of plants, invertebrates and vertebrates, has declined since 1970, with more species decreasing than increasing (Hayhow et al., 2019). In 2011, approximately 60% of designated sites in upland habitats (Mountains, Moorlands and Heaths) of Wales were classed as being in unfavourable condition (Russell et al., 2011). The greatest impact on the earth's systems have been, land use change for forestry, grazing and food production (Vitousek et al, 1997, Hayhow et al., 2019), especially in the 50 years leading up to the MEA (Tilman, 1999; Duraiappah et al., 2005; MEA; 2005; Hails and Ormerod, 2013). The post Second World War period drove agricultural policy change on a global scale; small family farms disappeared, and labour declined but yield increased four-fold due to mechanisation, chemical applications and changes to farming practices.

To counter biodiversity decline, the MEA (2005) suggested a shift towards an ecosystem services approach to land management (Duraiappah et al., 2005). Although possible, it would require policy change and trade-offs between different ecosystem categories (Hauck et al., 2012). The UK responded by conducting its own assessment (UK National Ecosystem Assessment, 2014) which reinforced the conceptual framework generated by the MEA . These assessments attempted to identify links between ecosystems, ecosystem services, good(s), valuation, and human well-being. Many organisations have strived to unravel the complexities of ecosystems, place values on their services and understand the economics of delivery (TEEB, 2010; Farley, 2012; Potschin and Haines-Young, 2013; Díaz, et al., 2015; Kovács and Pataki, 2016). Economics describe the flow of ecosystem services as the benefits society receives from natural capital. If natural capital stocks are maintained, the flow of ecosystems services is sustained, and the well-being of future generations is secured (TEEB, 2010). If the ultimate goal is human well-being, then the value of ecosystem services equals the relative contribution they contribute to achieving that goal (Costanza et al., 2014).

Environmental goods and services are often referred to as non-market goods and services or public goods which are non-excludable and non-rivalrous (Fisher et al., 2009; Costanza et al., 2014). They can be described as having ‘use values’ such as timber, food fuel or ‘non-use values’ which is the level of importance attributed to an ecosystem service (De Groot et al., 2002). Allocating monetary values to ecosystem services allows for cost benefits analysis (Defra, 2007) but its effectiveness is subject to on-going debate (Kati and Jari, 2016; Kenter et al., 2016). Ecosystem services such as regulating services e.g. controlling climate change, water quality and soil formation, are invisible to the majority of society. This invisibility leads to natural capital neglect as little value is placed on the service by individuals or in wider society (TEEB, 2010).

Values can be separated further into individual and social values (TEEB, 2010; Smith and Sullivan, 2014; Brien et al., 2015). The debate surrounding individual values are complex; some argue that individual choices on the environment are predominantly driven ethically and socially by influences imposed on the individual at societal levels (Brien et al., 2015). Others (UKNEA, 2014), suggest individual behaviour is dominated by self-interest and self-regarding motives. Individual and social values identification is complex, values vary between individuals within and between groups. The policy of some nations focus on individual rights whilst others concentrate on social and community level values (Díaz et al., 2015). Farber et al. (2002) highlight this complexity stating, "There is clearly not one ‘correct’ set of concepts or techniques to address this important issue". They argued that valuation is about assessing trade-offs towards achieving clearly defined goals (Costanza et al., 2014). Current sustainable development policy focuses on the 'Sustainable Well-being' concept (Colglazier, 2015; UN, 2015; WG, 2015; Hicks et al., 2016; WG, 2019b) which Costanza et al. (2014) argue is a much larger goal than that of policies focused on individual perceptions of benefits received from ecosystem services. If ecosystem services contributions to human well-being are to be effectively assessed in terms of value, then methods to assess benefits to individuals, whole communities and to sustainability must be included and trade-offs identified (Farley, 2012; Costanza et al., 2014). Trade-offs occur between ecosystem services - normally provisioning and regulating services (Pilgrim et al., 2010; Martinez-Castillo, 2016; Spake et al., 2017) or between the natural environment and the socio-economic needs of the local populace (Howe et al., 2014; Lázár et al., 2020). These are often difficult to identify due to varying scales over which ecosystem services operate and the often complex, and shifting social-ecological-economical systems (Reed et al., 2013).

Discussions surrounding trade-offs often mention the creation of win-win situations where all stakeholders benefit (Zheng et al., 2019) but, in reality, win-win situations are the exception, not the rule (McShane et al., 2011; Howe et al., 2014). Trade-offs are influenced by policy change and policy change is driven by political goals and self-interest (Aidt, 1998). In the New Zealand Model, political ideology and self-interest drove policy change, removed financial support to agriculture and significantly altered farming practices (MacLeod and Moller, 2006). This drastic change led to reduced sheep farming and increases in dairy farming, the result of market forces. Smallholdings, unable to survive, were engulfed by large corporate enterprises. The result was the creation of negative externalities (Ministry for the Environment, 2015) such as:

- New Zealand's net GHG emissions increased 42% between 1990 and 2013. Emissions from agriculture was the largest contributor at 48% (mainly CH_4 emissions from cattle and sheep)
- Statistically significant increases in total nitrogen levels in >60% of sites since 1990, most likely to be due to an increase in nitrate leaching through soils, as a result of more intensive agriculture – especially from dairy farming expanding and intensifying in many regions.
- Dairy farming is the main driver of recent farming intensification. Between 2002 and 2012, the area of dairy farming in New Zealand increased 28%. Most of this expansion was made by converting sheep and beef farms, which decreased in area by almost 11%, to dairy enterprises.
- A decrease of more than 10,000 hectares in indigenous forest and regenerating forest (broadleaved indigenous hardwoods) occurred between 1996 and 2012.

The UK Environmental Audit Committee (2017) warns of similar consequences in a post-Brexit UK if steps are not taken to identify, and address, potential negative trade-offs, socially and environmentally. In the UK, direct financial support will be removed, but the UK and Welsh governments aim to avoid the negative impacts seen in New Zealand through the introduction of the Environmental Land Management Scheme in England (Defra, 2018a) and the Sustainable Land Management Scheme in Wales (WG, 2019b). These schemes will require significant changes in farming practices and the role of farmers within the landscape, but not all businesses will fit the 'public money for public goods' criteria and will therefore have to adapt in other ways (Mansfield, 2019).

2.6. Options for Change in the Delivery of Environmental Targets

If top-down, options-based AES fail to effectively deliver environmental outcomes (Batary et al., 2015) or create long term changes in farmers attitudes towards environmental practices (Hyland et al., 2016) then future options may lie elsewhere. Bennett (2017) argues that whilst the land sparing/sharing argument focused attention on the intersection between food security and conservation, it is now time to move forward and address the question of how to ensure human well-being. She suggests doing so will require an understanding of ecosystem services within the agricultural landscape, and the social factors that contribute to human well-being and food security (Bennett, 2017). The UK government also suggests change, as the 2050 net-zero target will not be met without changes in how we use our land (CCC, 2020). Farmers must adopt strategies which reduce land-based emissions of greenhouse gases while also contributing to other strategic priorities for land such as food production, climate change adaptation and biodiversity (CCC, 2020). Upland grazing livestock farming is marginal and less profitable than other farming enterprises because the productivity of the land is limited, often severely, by physical factors such as harsh climate, short growing season, poor soil fertility and drainage, steep slopes and high altitudes (Reed et al., 2009). These limiting factors reduce the options available to the upland famer. It is very unlikely that improving productivity will be achieved by increasing production. Farmers will have to explore other methods to increase opportunities from the agricultural income stream including, optimising efficiency and profitability by decreasing inputs and maximising forage and grassland utilisation (ADAS, 2019). Other options include collaborative working to reduce fixed and variable costs by sharing machinery, labour and joining buying groups for inputs such as feed and veterinary products, exploring PES schemes funded partially or completely by the private sector and the goods ‘criteria implementation of future land management schemes, focussed on the delivery of public goods or ecosystem services (ADAS, 2019). Many farmers have shown a keen interest in participating in future ‘Public Goods Schemes’ (ADAS, 2019; NFU Cymru, 2020) with many choosing to follow the natural and sustainable farming route as they believe it is not only a more profitable way of farming, but also more sustainable, from an environmental and economic point of view (NFFN, 2018). Public goods delivery, on a large scale, may not be an option for all, especially in the lowlands. If the agricultural sector as a whole, is to meet 'Net Zero' climate change and biodiversity targets it will require changes to farming practices across all sectors (CCC, 2020).

Alternative farming systems (Box 1) can achieve high yields and profit, but for high-yield systems to generate any environmental benefits they must be coupled with efforts to reduce negative externalities e.g., higher profits or lower prices stimulating land conversion, and damage to human health through the overconsumption of cheap, calorie-rich but nutrient-deficient foods (Balmford et al., 2018). Decision making surrounding high yield farming practices should account for the socioeconomic consequences of farming systems and recognise that agricultural sustainability will depend on the actions of government and civil society, rural communities and land managers and researchers and field technicians (Garibaldi et al., 2016).

The multi-dimensional agroecology approach to land management is well researched and cited as containing practices which could lead to the sustainability of agriculture (Francis et al., 2003; Wezel et al., 2014; Martinez-Castillo, 2016). Agroecology takes an approach to agriculture which is more linked to the natural environment, more sensitive from a social perspective, centred around sustainable production, and integrating ecological phenomena that occur in a cultivated field (Martinez-Castillo, 2016). Agroecology, conceptualised as a farmer-led countermovement against the modern agri-food system, is an evolving field of environmental, social and politico-economic activity which faces similar challenges to other sustainable agricultural practices, namely, measuring success, scaling up, farmer perceptions, and questions about productivity and the role of the state (Bellamy and Ioris, 2017). The need to increase sustainability in agroecosystems has led to increased research into the concept of sustainable intensification (SI). Its name implies a desire for successful outcomes in the delivery of both production and environmental goals but the mention of "intensification" in any environmental concept creates controversy (Pretty and Bharucha, 2014). SI aims include elements of land sharing e.g., agri-environment schemes, alongside elements of land sparing such as biodiversity offsetting and improved land use targeting (Franks, 2014). The pursuit of SI requires a major programme of co-ordinated scientific research that involves social sciences as much as natural and agricultural sciences (Godfray and Garnett, 2014).

Box 1. Different Modes of Farming System (Garibaldi et al., 2016)

Agroecology – contribute to improving the sustainability of agroecosystems while being based on various ecological processes and ecosystem services such as nutrient cycling, biological N fixing, natural regulation of pests, soil and water conservation, biodiversity conservation and carbon sequestration (Wezel *et al.*, 2014).

Sustainable Intensification – the focus of sustainable intensification is to produce more food with less environmental impact (Godfray and Garnett, 2014).

Diversified farming – describes farms that integrate a number of different crops and (or) animals. Linked to agroecology and ecological intensification. It focuses on cross-diversification for sustainable production (Garibaldi et al., 2016).

Ecological intensification of agriculture (EI) - aims to conserve and promote biodiversity and the sustainable use of associated ecosystem services to support resource- efficient production (Geertsema *et al.*, 2016).

Organic farming - not only increases plant diversity, but also simultaneously promotes biological weed control through provisioning of ample resources to seed predators (Diekötter *et al.*, 2016)

Climate smart agriculture - an approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change (Lipper *et al.*, 2014).

In the UK, this need was met by the Sustainable Intensification Platform (SIP, Defra, 2017) which included interlinked research projects involving agricultural, environmental and social scientists, economists, stakeholders and policymakers from over 30 organisations (universities, charities, consultancies and government agencies). One of the aims of the platform was to investigate integrated, collaborative approaches to enable farmers to increase farm productivity while simultaneously improving environmental performance (Turner, 2011; Jarrett et al., 2015). This study found that coordinated and collaborative initiatives have the ability to improve ecological conditions; increase the cost-effectiveness of individual actions; improve productivity (in some cases); bolster social cohesion and knowledge exchange within the farming community; help tackle local land management issues; and positively engage the wider community in landscape scale conservation (Jarrett et al., 2015). However, social sustainability is critical to support farmers' capacity to work together for such ends (Wynne-Jones et al., 2020). Evidence shows that there is less co-operative behaviour between farmers now than in the past as a result of the mechanisation that has occurred across UK agriculture, the decrease in time available for co-operation, and the continuing decline in the number of farmers (Burton et al, 2005, Mansfield, 2008). The SI concept is seen by many as an oxymoron and confusion over its meaning calls into question the usefulness of SI as a concept (Franks, 2014; Gunton et al., 2016). Gunton et al. (2016) describe the way SI is defined and developed as, "lacking engagement with established principles that are central to sustainability". There is no 'one size, fits all' solution, no concept can be expected to encapsulate within it the diverse nature of food security and sustainability (Garnett et al., 2013; Franks, 2014). SI should therefore be seen as part of a wide range of initiatives and efforts to create greener economies (Pretty and Bharucha, 2014). Other alternatives to conventional farming such as diversification, ecological intensification, organic farming and climate-smart agriculture (Box 1) all have similar objectives as agroecology and SI namely, they all look to produce food using a sustainable approach.

2.6.1. Public money for public goods

As the UK moves out of the EU it will enter a 7-year transition period which will see farmers having to adapt to life without direct subsidies (UK Parliament, 2020). Funding will be available, but if farmers want to access 'public money' they will have to deliver 'public goods' and this is likely to lead to significant changes in farming practice. The CCC (2020) have identified several areas that will require rapid changes in farming practices and consumer behaviour (Fig 2.7). These changes are such that they will aim to release around one-fifth of agricultural land by 2050 for actions that reduce emissions and sequester carbon (CCC, 2020).

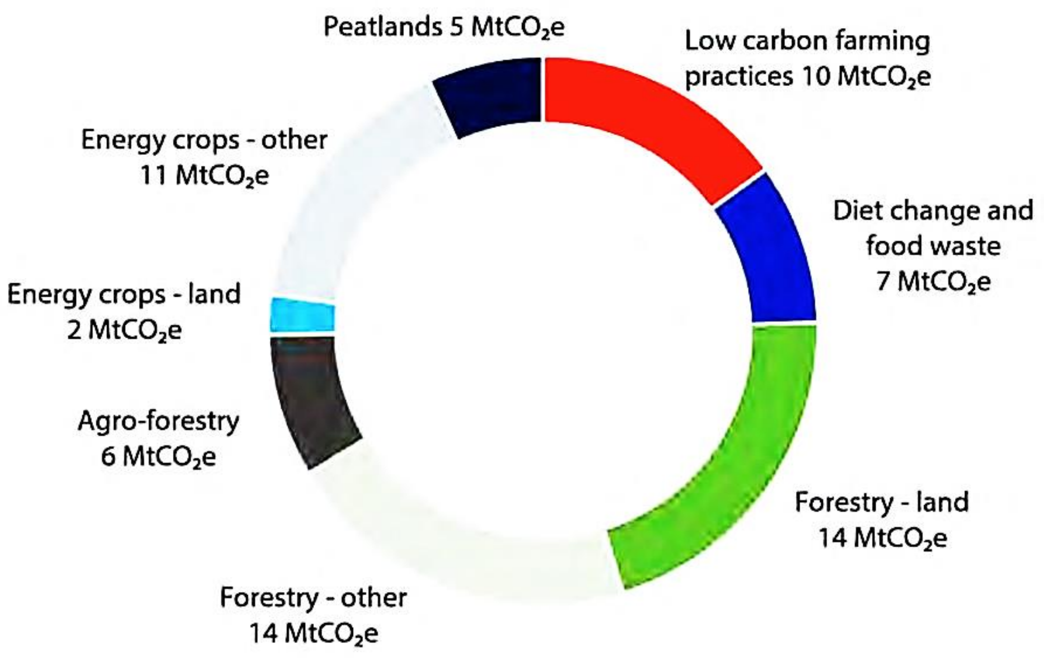


Figure 2.7. GHG savings from measures to reduce agriculture and land use emissions by 2050. Source: CCC, 2020.

The CCC has ambitious targets and a pathway that requires;

- An increase in tree planting of both productive conifers and standing broadleaved woodland, to at least 30,000 hectares per year to 2050.
- Average planting rates of miscanthus, short rotation coppice and short rotation forestry to reach 23,000 hectares per year from the mid-2020s.
- The area of cropland and grassland planted with trees increases to 10% by 2050, and the area of hedgerows increases to around 181,000 hectares by 2050.
- Fifty percent of upland peat, and 25% of lowland peat is restored, and 25% of the area with low productivity trees is removed by 2050.

However, there is uncertainty in how far these levels of ambition can be achieved in practice and there will be a need for these targets to be updated with on the ground learning and ongoing research (CCC, 2020). Government officials, NGOs and stakeholders wanting to deliver on environmental goals and targets in the uplands must engage with farmers and landowners who must in turn agree to change. Without compromise, engagement and a common vision and agreement, it is almost impossible to achieve the goals and objectives of any stakeholder which relies on shared property resources (Mansfield, 2019). If the UK is to reach an ambitious target of Net Zero GHG emissions by 2050 all sectors of society including, industry, transport, aviation and shipping and buildings, will have a role in reducing carbon footprints (CCC, 2019). Individuals and households will need to consider how they travel, make efficiency savings at home, eliminate food waste, use peat free compost and look for ways that changes can be made make in the workplace or school to reduce (CCC, 2019). Agriculture will also be required to make changes if these targets are to be met. CCC (2020) land use scenarios suggest that sustainable agriculture productivity growth is key, as it allows more to be grown with less land and other inputs and enables land to be freed up for other uses. There is however concern, that Brexit and the removal of direct subsidy support may damage the contribution that the farming industry makes to social networks, social capacity, community resilience and other aspects of social and cultural capital in rural areas (Hill and Bradley, 2019). Policymakers must ensure that the drive for environmental sustainability in the more vulnerable upland areas, where economic sustainability is already threatened, does not come at the expense of social and cultural sustainability.

Agricultural production in Wales and Northern Ireland is dominated by livestock production, with milk and cattle production the highest value products. While these are also important in Scotland, one-third of output comes from crops. In England the top three agricultural products are horticulture, milk and poultry, with cereals dominating the east of the country and livestock the south west. In addition to sustainable practices there is an ambition to reduce consumption of what the CCC (2020) class as the most carbon-intensive foods (i.e., beef, lamb and dairy), by at least 20% per person and reducing food waste by 20% which is estimated would save 7 mt CO_2e of on-farm emissions by 2050. This aims to free up land from food production to enable deliver the ambitious targets needed to reach net zero GHG emissions. This potential reduction in demand will see farmers, especially in Wales and Northern Ireland having to look to other enterprises, such as public goods delivery, to secure farm viability.

The National Farmers Union (NFU, 2019) has set an even more ambitious goal of reaching net zero greenhouse gas (GHG) emissions across the whole of agriculture in England and Wales by 2040. They intend meeting these ambitious targets to tackle climate change in UK agriculture using a portfolio of different policies and practices focused on three key themes, or pillars:

- Pillar 1 (11.5 mt CO_2e by 2050) focuses on improving farming productive efficiency through measures aimed at improved soil quality, livestock health, diets and breeding, on-farm anaerobic digestion and energy efficiency of vehicles and buildings.
- Pillar 2 (9 mt CO_2e by 2050) is around increasing carbon storage in soils through measures such as hedgerows, woodland on farms, soil carbon practices, and peatland and wetland restoration.
- Pillar 3 (26 mt CO_2e) uses bioenergy with carbon capture and storage (CCS), using bio-based materials in industry and application of biochar to soils in the longer-term.

The CCC (2020) and the Welsh Government (2019a) are united in recognising that the Land Use, Land Use Change and Forestry (LULUCF) sector is the only one, which has the current capability to remove emissions from the atmosphere. To achieve a net-zero emissions goal the LULUCF sector will be required to be carbon negative to offset emission surpluses in other sectors (WG, 2019c). Clearly, substantial change in the use of land is necessary to achieve net-zero in the UK, but the scale of change required is not yet supported by policy (CCC, 2020). All farmers will have to adapt and change, but upland livestock farmers may have to adapt more than lowland livestock and arable farmers. Land suitable for sparing for forestry, peat restoration and biodiversity is more likely to be found in upland habitats whilst more productive land will more likely be used for increased sustainable production, it is therefore vital that farmers and land managers are kept on the land. If post-Brexit policy fails to deliver levels of support that allow farms to remain viable, this will potentially lead to land abandonment and a breakdown in the system that currently delivers biodiversity in the uplands (Dwyer, 2018; Barnes et al., 2020). Substantial change in the use of land is necessary to achieve net-zero in the UK, but the scale of change required is not yet supported by policy. Gaps in current policy and a patchy framework of support for farmers and landowners, will not deliver improvements at the pace required to meet the net-zero goal (CCC, 2020). If low-carbon farming practices are to be implemented a range of social, economic and behavioural barriers will need to be overcome. The CCC (2020) identify the following as potential barriers: inertia (difficulty for newcomers with the right skills to enter the market), lack of knowledge (experience and skills in applying farming techniques) and practices and contractual arrangements that may constrain uptake amongst farms that are tenanted or designated as common land.

2.7. Conceptual framework

This section spells out the details of the conceptual framework which guided this research. It provides details about what conceptual frameworks are and reasons why conceptual frameworks are important in improving the quality of research. It then describes the constructs which make up the conceptual framework for this study and the relationships between them. In literature, there is a common understanding that a conceptual framework is a key component of a study design (Tamene, 2016) as it is the document that "explains, either graphically or in narrative form, the main things to be studied and the key factors, concepts, or variables; and the presumed relationships among them (Miles and Huberman, 1994). However, the meaning of conceptual framework is not clear and often used with theoretical framework interchangeably, though their conceptual meaning is basically different (Imenda, 2014; Antonenko, 2015).

A theoretical framework refers to the theory that a researcher chooses to guide him/her in his/her research. Thus, a theoretical framework is the application of a theory, or a set of concepts drawn from one and the same theory, to offer an explanation of an event, or shed some light on a particular phenomenon or research problem (Imenda, 2014). A conceptual framework can be described as a system of concepts, assumptions, expectations, beliefs, and theories that supports and informs your research (Maxwell 1996; 2004). It is primarily a conception or model of what is out there that you plan to study, and of what is going on with these things and why; a tentative theory of the phenomena that one is interested in investigating (Tamene, 2016). The review of previous literature in this chapter enabled the development of a conceptual framework comprising the primary social, economic and environmental drivers of agricultural land use change, farmer characteristics impacting the decision-making process and potential options for land use change in the uplands (Fig. 2.8). Following a UK exit from the EU and the introduction of new UK agricultural policies, direct payments are to gradually be removed over a 7-year transition period. The resulting financial pressures, especially on the upland grazing livestock sector may accelerate structural and land-use change, including agricultural land abandonment in more marginal locations (Franks, 2016; Dwyer, 2018; Hubbard et al., 2018).

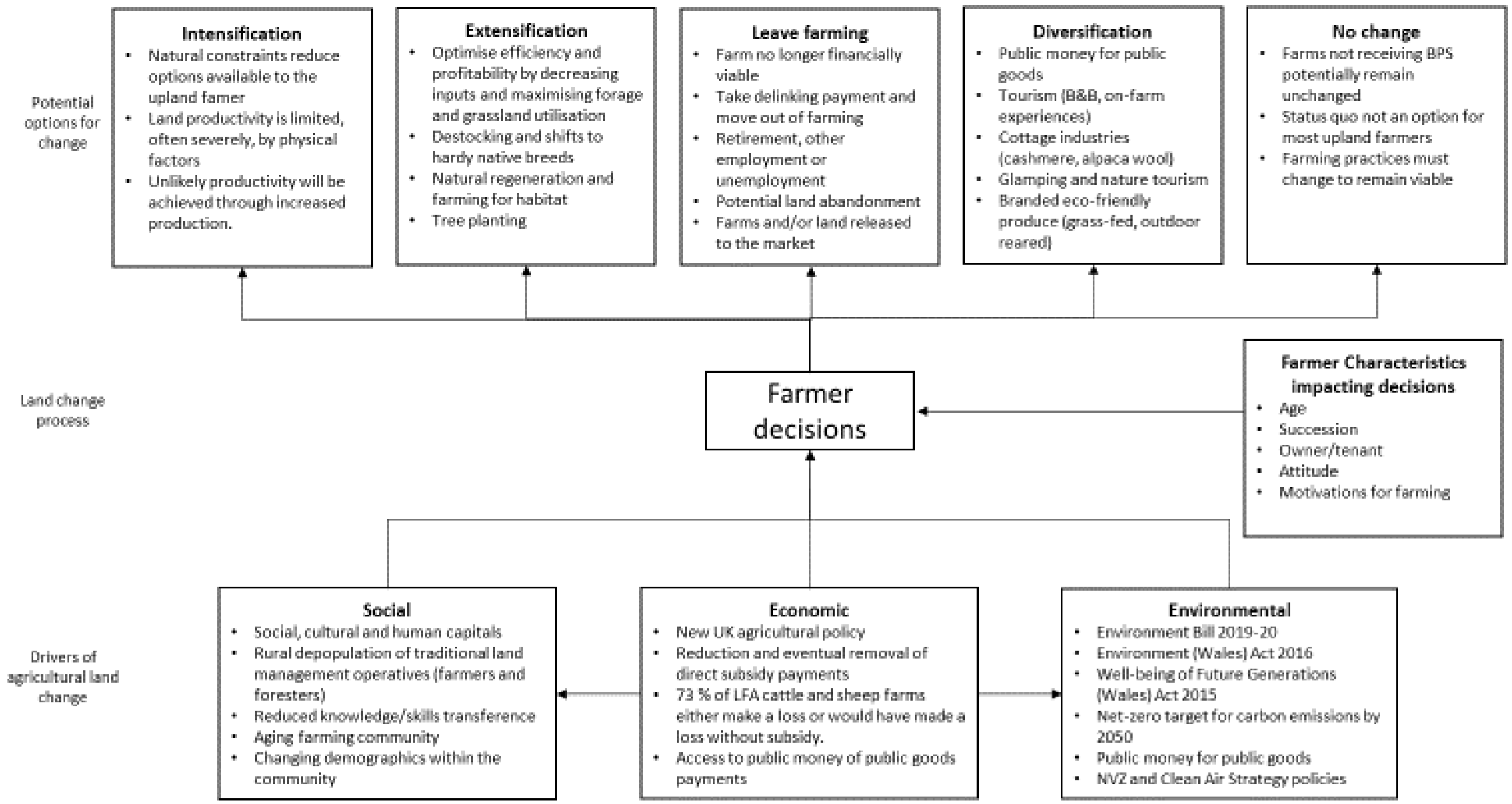


Figure 2.8. Conceptual framework of potential options for change and drivers of agricultural land use change in the UK uplands.

This framework guides the research project as it investigates the key drivers of change across the three pillars of sustainability, social, economic and environmental and explores the relationship between them. It also gives structure to the various experimental chapters which strive to identify how these drivers of change influence farmers decisions and the future sustainability of farming systems in the uplands.

Fig. 2.9 shows the key drivers of economic and environmental change and highlights key areas of interconnectivity between the social, economic and environmental sustainability pillars. It shows how the thesis objectives explore the interaction between the three pillars upland farming systems.

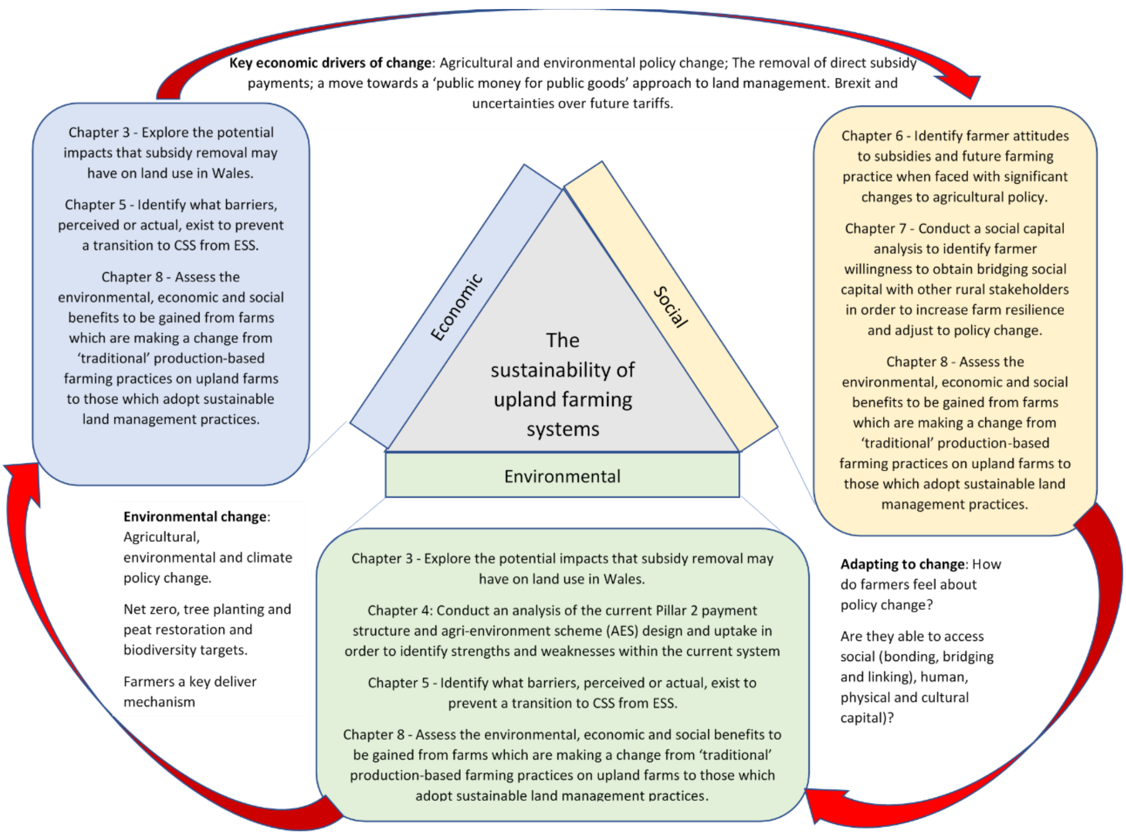


Figure 2.9. A sustainable development framework to identify barriers and opportunities to sustainability in upland farming systems following agricultural and environmental policy change.

This framework is used to identify barriers and opportunities to the sustainability of upland farming systems and explore solutions to some of the challenges faced by policymakers aiming to deliver public goods in what is currently upland agricultural landscapes.

2.7.1. Drivers of agricultural land use change

2.7.1.1. Economic

A UK exit from the EU will also see an exit from the Common Agricultural Policy's support framework, the primary driver of UK agricultural policy change since 1974 (Wallace and Scott, 2018). The introduction of new UK agricultural policies in England and the devolved nations will be the main force driving change across the agricultural industry, especially the upland grazing livestock sector. Its implementation and the proposed removal of direct subsidy payments is likely to have environmental a significant economic impact on upland farmers and this in turn will drive social and environmental change and ultimately influence the farmers decision on future farming practice.

Section 2.1.3 shows the uplands of the UK differing in topography, meaning farmers in one area may be able to adapt better than others but common factors impacting all areas are natural constraints which limit productivity meaning that upland farms are predominantly extensive beef and sheep farms. Section 2.2.2 shows upland beef and sheep farms being the most reliant on subsidy support with Defra (2018e) estimating the bottom 10% of farms, based on profitability, will need to reduce input costs by 31% just to break even. Given the natural limiting factors affecting productivity and the fact that sheep farming is only profitable if farmer and spouse labour is unpaid (section 2.2.2), it is highly unlikely that all farms will be able to adapt to change and remain financially viable without support payments. Defra accepts that proposed policy changes will accelerate structural change, increase the rate at which farms cease trading and release land to the market (Defra, 2018b; Franks et al., 2019). This may see farm size change as farms expand to gain access to more public money through ELMS and SLMS and provide opportunities for younger farmers to gain entry into the farming sector as owners or tenants.

There will be options to improve financial viability and sustainability, but it is likely to involve significant changes to farming practice and the adoption of more extensive farming practices which see the farmer producing public goods in exchange for public money. The removal of subsidies will not be immediate, there will be a transition period, lasting 7 years in England and yet to be agreed in the devolved nations, and during this time payments will be delinked (section 2.2.2) meaning recipients will no longer have to farm to receive payments. This means that farmers have an opportunity to use payments to invest in their business, diversify or alternatively, they could take a one-off lump sum payment and retire or move away from farming. As payments reduce during the transition period, payments for public goods will be introduced through ELMS (Defra, 2018a) in England and SLMS (WG, 2019b) in Wales. These will give farmers the opportunity to receive payments to deliver public goods such as clean water, clean air, thriving plants and wildlife, protection from environmental hazards, reduction of and adaption to climate change and beauty, heritage and engagement with the environment (Defra, 2018a; WG, 2019b).

Farm Business Surveys provide valuable data to enable benchmarking and monitoring of changes in average farm incomes however, this data can be skewed by large farms receiving substantial Pillar 1 payments. This study will use Chapter 3 to remove some of this variation through the use of a dataset which combines Agricultural Survey Data with RPA payments data (Fig. 2.9) and identify those farms most and least likely to be impacted by subsidy removal. It will use Chapter 5 to identify barriers to the adoption of AES, primarily the Countryside Stewardship Scheme in England, as it will be the only AES available for a 3-year period as ELMS roles out and it may be an indicator of future behaviour (Fig. 2.9). Finally, Chapter 8 is used to assess the economic, social and environmental benefits to be gained from farms making the transition for ‘traditional’, production-based farming practices to more extensive practices which reduce inputs and adopt sustainable land management practices.

2.7.1.2. Social

In traditional upland farming systems previous policy change has driven farmers numbers down. Section 2.1.3 shows there is widespread evidence the upland farmed landscape is changing at the international, national, regional, and local levels (Gaskell et al., 2010; Lobley and Butler, 2010; Barnes et al., 2020). These changes have led to a transformation in the character and structure of rural communities. Traditional cooperative activities, such as hay and silage making, shearing and fell gathering, the gathering of sheep for lambing and shearing and farmer involvement in community activities are in decline (Burton et al., 2005). Reductions in farmer and farm labourer numbers means that time-consuming activities such as the management of common land is in decline as farmers no longer exercise their right to graze (Mansfield, 2018). The economic impact of policy change identified in sections 2.2.2 and 2.7.1.2. will undoubtably have a further impact on farmer numbers in the upland and this in turn will have a social impact as communities adapt and change to new situations. A reduction in less effective and financially non-viable farms may increase the financial and social sustainability of the remaining viable farms but if farmer numbers reduce too far the uplands could reach a point where they are no longer socially or environmentally sustainable (Barnes et al., 2020).

Social capital, the degree of connectivity of a farmer with other farmers and with people and organisations outside of their immediate network is effective and a key factor in adapting to change (Section 2.1.3). Declining farmer numbers, especially in remote upland regions increases isolation (Dax, 2005; Barnes et al., 2020; section 2.1.2), and health of individuals (Becker, 2002). It is imbedded in people and it grows through use and experience gained through employment and formal and informal learning, but it also tends to depreciate through lack of use (Healy and Côté, 2001; section 2.3.1). Coleman (1988) found social capital, both in the family and within the community, having a role to play in the development of human capital within the rising generation. Further rural depopulation, changing community demographics and a lack of access to externa resources can undermine the human capital that ensures the skills and knowledge needed to manage the land for environmental sustainability are lost. Furthermore, declining farmer numbers will impact upon cultural capital (section 2.3.1) which can be tangible e.g., heritage buildings, stone walls, traditional barns, or intangible e.g., values, beliefs and perceptions that form the culture of a group.

An understanding of personal values and beliefs are fundamental in assessing farmers motivation for adopting environmental measures (Sulemana and James, 2014), a key factor in promoting ELMS and SLM and a 'public money for public goods' approach. This study will use Chapter 6 to identify farmer attitudes to subsidies and future farming practice when faced with significant changes to agricultural policy (Fig. 2.9). It will use Chapter 7 to conduct a social capital analysis to identify social capital levels and farmers' willingness to obtain the bridging and linking social capital that may help them adapt to change. Chapter 8 is used to assess the economic, social and environmental benefits to be gained from farms making the transition for 'traditional', production-based farming practices to more extensive practices which reduce inputs and adopt sustainable land management practices.

2.7.1.3. Environmental

The environmental sustainability of the uplands will be impacted by both economic and social factors. The top-down approach delivers policies (section 2.4.1) which aims 'to meet the needs of the people' e.g., the Well-being of Future Generations (Wales) Act 2015' (Davies, 2016); maintain and improve environmental protections e.g., the Environment Bill 2019-20 (UK Parliament, 2019 and the Environment (Wales) Act 2016 (WG, 2016) and meet climate change targets e.g., ‘Prosperity for All: A Low Carbon Wales’ (WG, 2019c) and Net Zero: The UK's contribution to stopping global warming (CCC; 2019). All these policies require significant changes to farming practice as land is required for tree planting, short rotation coppicing and forestry, low carbon farming practices and peatland restoration (section 2.6.1). However, there is uncertainty in how far these levels of ambition can be achieved in practice. Government officials, NGOs and stakeholders wanting to deliver on environmental goals and targets in the uplands must engage with farmers and landowners who must in turn agree to change. Without compromise, engagement and a common vision and agreement, it is almost impossible to achieve the goals and objectives of any stakeholder which relies on shared property resources (Mansfield, 2019).

Economic drivers (section 2.2 and 2.7.1.1) have the potential to impact on environmental targets and goals positively or negatively. If farmer numbers reduce drastically this could lead to land abandonment which could see higher deer numbers, increased rank vegetation, scrub and birch tree regeneration (and associated increased fire risks), declining farmland birds, decreases in rabbits and hares, increased ticks (and associated tick-borne disease), reduced wetland waders and a decrease in species diversity (Thompson et al., 2011; sections 2.1.3 and 2.3.1). However, if viable farms embrace schemes like ELMS and SLMS or PES such as Wild Ennerdale or SCaMP (section 2.8.1) then progress may be made in achieving net zero and environmental targets. Section 2.2.4 shows the effectiveness of current action-based AES being challenged and some suggesting a results-based approach would be more efficient and cost-effective (Burton and Schwarz, 2013; Schroeder et al., 2013; Reed et al., 2014; de Sainte Marie, 2014; Chaplin et al., 2019). Indeed, both ELMS (Defra, 2018a) in England and SLMS (WG, 2019b) state they will take an outcome-based approach over an action-action-based approach.

Economic and social drivers will play a key part in incentivising farmers to deliver public goods on a large scale. Payments must be at a level that enables the farmer to remain financially sustainable and farmers must be given the support, training and advice to help them access the bridging and linking social capital that will enable them to access the resources needed to build the human capital needed to deliver outcome-based AES. This study will use Chapter 3 to explore the potential impacts that subsidy removal may have on land use and the environment (Fig. 2.9). Chapter 4 will explore the current Pillar 2 payment structure and AES scheme designed option uptake to identify strengths and weakness in the current system and Chapter 5 will identify barriers to participation in the Countryside Stewardship Scheme in England (Fig. 2.9). Chapter 8 is used to assess the economic, social, and environmental benefits to be gained from farms making the transition for 'traditional', production-based farming practices to more extensive practices which reduce inputs and adopt sustainable land management practices.

2.7.2. Farmer characteristics

Policies that reduce farm household's dependence on on-farm income e.g., ones that remove direct payments, could have the externality benefit of bringing more farms into AES. This study also found education, age, and the presence of a successor to influence participation and farm size and levels of payment playing a significant role in accessing AES (Lastra-Bravo et al., 2015). Access to social capital (Mathijs, 2003), previous experience of AES (Lastra-Bravo et al., 2015) and attitudes to the environment (Hyland et al., 2016) are also key drivers in AES uptake. The UK has an aging farming community with the a third of farmers being over the age of 65 years while the proportion of farmers aged <35 years was ~3% (section 2.1.3) and only 43% of farmers state they have a successor to take over the business (section 2.1.3). This could potentially influence decisions to change farming practice or leave farming. This study will explore how demographics influence attitudes to subsidies and future farming practice through a farmer survey in Chapter 6. I will also use Chapter 5 to see how demographics influence a willingness to participate in AES.

2.7.3. Potential options for change

The economic, social and environmental drivers of change in the agricultural sector, identified in this literature review show that change is inevitable and that farmers, especially upland farmers most effected by policy change, will have to make some difficult decisions if they are to remain viable. Upland farmers face more restrictions that lowland farmers and this limits their options (section 2.1.2).

2.7.3.1. Intensification

LFAs are areas with natural and socio-economic disadvantages (section 2.1.2), agricultural production is ither severely restricted or restricted in its range virtue of the adverse soil, relief, aspect or climate, or by a combination of these (Backshall et al., 2001). The low productivity of these areas reflects a limited production set which constrains the ability to generate a sustainable household income directly from agricultural production (Barnes et al., 2020). These factors combined with the fact that sheep farming in the UK is deemed to be financially non-viable without subsidy support means that it is unlikely that intensification is a viable route to economic sustainability for the upland farmer. This study will explore options for change in Chapters 3 and 8. Chapter 5 will, through the use of a farmer survey, endeavour to identify what famer type view intensification an option post-subsidy removal.

2.7.3.2. Extensification

Extensification and a move towards a public money for public goods approach to farming in the uplands may be an option that provides many farmers with the opportunity to remain on the land (section 2.2.2). Economic drivers may play a key role in nudging farmers down this route, but payment levels are likely to significantly influence the decision-making process (section 2.2.2). However, economic drivers alone may not be enough to encourage farmers to join E and PES schemes to the levels required to deliver the ambitious targets laid down in policy (section 2.4.1). Economic incentives may be able to financially motivate behavioural change but they cannot replace the social and cultural capitals that are needed to develop the ethos, beliefs and knowledge required to implement change and underlie policy instruments (Paragahawewa, 2011; section 2.3.1). Social drivers are likely to play a significant role in the decision-making process.

Social capital provides the social connectivity required to access the resources required to build the human capital required to enhance the natural and cultural capitals of the uplands and deliver the levels of public goods required to meet net zero climate change and government environmental targets. All of these capitals are interlinked, and a reduction in one will have a detrimental effect on the others, therefore if future policy aims to deliver public goods in the uplands of the UK it must also address issues impacting upon levels of social and human capital (Mansfield, 2018; section 2.3.1). If future schemes are to successfully recruit the levels of farmers required to deliver public goods at a landscape level, they must take into account the impact of varying capitals upon a community and 'recognise that farmers also need to preserve a way of life, a sense and a value for their professions', rather than challenging their 'professional identities' (Burgess et al. 2000). This study will identify which farmer types are willing to adopt extensive farming practices through a farmer survey in Chapter 5. In Chapter 7 it will explore how social capital can hinder or enhance a willingness to adopt more sustainable farming practices and in Chapter 5 it will identify where there are barriers and opportunities to the uptake of AES. Chapter 8 will use case study farms which have already transitioned to extensive farming practices to create scenarios to explore the social, economic and environmental benefits of extensification.

2.7.3.3. Leave farming

Given the dependence of many UK farms on direct payments, their removal is likely to see many beef and sheep farms struggling to survive, as they tend to be much more reliant on direct support (Dwyer, 2018; Hubbard et al., 2018). Defra accepts that proposed policy will most likely see some farmers leaving the industry and that policy changes will accelerate structural change, increase the rate at which farms cease trading and release land to the market (Defra, 2018b; Franks et al., 2019; section 2.2.2). There are some options available to farmers wishing to retire or move away from farming. Delinking payments (section 2.2.2) will see those farmers prepared to give up farming being offered the opportunity to take a one-off payment of all the payments the farmer would have received during the transition period. These payments are intended to help farmers relocate or seek employment in other areas (section 2.2.2). There is however a risk, especially in the short term, of land abandonment (section 2.3.1) as farmers reduce farming activity by try to remain on the land. In Chapter 3, this study will use CAP payments data combined with June Agricultural and RPA data to identify the percentage of farmers financially vulnerable post-subsidy removal and therefore those most at risk of leaving farming. It will use the findings in Chapter 3 in Chapter 8 to explore which show the beef and sheep grazing livestock sector under various restructuring scenarios. In Chapter 5, a farmer survey will be used to ask farmers if they would be prepared to leave farming should they be forced to reduce or move away from food production.

2.7.3.4. Diversification

The scope of this study does not measure income from diversification income. Farm Business Survey data show that 66% of farm businesses in England had some diversified activity in 2017/18. This study assumes that at a minimum, this level of diversification income will be maintained and will actually increase as restructuring occurs. In Chapter 8 scenarios exploring restructuring will measure the environmental benefits of diversification into forestry and PES involving natural regeneration at a landscape level and will discuss potential socio-economic benefits and threats arising from this restructuring.

2.7.3.5. No change

Socio-economic and environmental drivers of change (sections 2.2, 2.3 and 2.4) show that change in the agricultural sector is inevitable. Indeed Defra (2020d) have released a publication entitled 'Farming is Changing' in which it summarises the policy changes and options available to farmers discussed in section 2.2.2. For most upland beef and sheep farmers maintaining the status quo is not an option however, there are some farmers for which policy change may not have as much of an impact e.g., those who currently do not receive direct subsidy payments. In Chapter 3, CAP payments data combined with June Agricultural and RPA data will be used to identify those least likely to be affected by subsidy removal and therefore those least likely to have to change. This data will be used when creating restructuring scenarios in Chapter 8.

2.8. Conclusion

Growing, and economically developing populations place demands on food systems, which have historically depleted the world's ecosystem services. This literature review highlights the complexities facing decision makers responsible for the implementation of policies, which feed this increased demand whilst ensuring sustainability across, social, economic and environmental boundaries. Global, and in some cases national, environmental policies are often not fully implemented or are distorted through conflicting political agendas. If outcomes of a policy are to be effectively assessed for success the true aims and goals of the policy must be identified, e.g., are AES predominately environmental or social policies? Sustainable development policies like the Welsh Government's 'Well-being of Future Generations Act' aim to deliver across a multidimensional arena but the variety in pillar objectives often means success in one area means failure in another. AES and PES can be effective at delivering both social and environmental benefits, but they must be targeted and ideally results-based to enable delivery of human, social and cultural capital. These capitals can be best delivered through collaborative or coordinated schemes, which involve interaction between participants. Decisions to participate in AES/PES or alternative farming systems are shaped by self-identity and research has shown that a better understanding of farmer needs and attitudes and perceptions will help identify their willingness to participate in schemes, or otherwise. There is no quick solution in the pursuit of sustainability, there must be an understanding of the trade-offs between the social, economic and environmentally sustainable development pillars and any externalities, both positive and negative that occur as a result of trade-offs if future decision making is to be informed and successful.

The UK has set a target to have net zero carbon emissions by 2050. To deliver on this target significant change in both diet and land use will be required. Farmers and land managers will have to adapt their practices to free up land to be used to increase the carbon sink levels of the LULUCF sector. However, there are likely to be barrier to adoption of low-carbon practices and policy frameworks are not yet in place to provide support for farmers and landowners as they make a transition towards net-zero practices.

2.9. Future Research Opportunities

Several research opportunities have been identified during this review. Burns et al. (2016) identify a major research gap, which is very relevant in the current UK situation, i.e., the extent to which changes in policy affect ecosystem services deliver and natural outcomes. Vidal-Legaz et al. (2013) in their study into trade-offs between the maintenance of ecosystem services and socio-economic development in mountainous regions in Spain identified the need to explore the effectiveness of policy interventions under different scenarios. Post-Brexit, agricultural and environmental policy will be significantly different to the CAP. Farmers will have to adapt to life without direct subsidies. Data collected through Farm Business Surveys (FBS) enables benchmarking and the monitoring of changes to average farm income that occur over time. However, large farms receiving substantial Pillar 1 payments can heavily skew average incomes, concealing considerable national variation in farm level incomes. In this study we will aim to contribute to the literature on policy change and remove some of this variation through an analysis of the CAP payments dataset and June Agricultural Survey data.

I have shown that the effectiveness of AES on biodiversity is widely debated in literature but there is little or no research on how option uptake and scheme structure impacts effectiveness. Here I will aim to close this knowledge gap through a study of the Welsh Glastir AES and the English CSS. Opdam et al. (2016) suggest a need to have a better understanding of the social dynamics surrounding collaborative PES schemes, whilst de Krom (2017) recommended further research into the social relationships between farmers and other rural stakeholders. There is little knowledge on the differences in type and level of social capital between farmer's groups in AES, not in AES and those who carry out high nature value farming above and beyond that required to state-run AES. I aim to contribute to the literature through a qualitative study within these farmer groups.

More research is needed in understanding the nature and evolution of farmer identities (Sulemana et al., 2014) and farmers' values of the perceived importance, manageability and vulnerability of ecosystem services as well as the threats to these services across various agricultural industries (Smith and Sullivan, 2014). I will conduct a farmer survey to contribute to the literature on policy change and the delivery of public goods.

Finally, there is little or no literature which identifies the level at which upland farmers may have to adapt farming practices to meet net-zero carbon emission targets whilst remaining economically and socially sustainable. I will aim to close this knowledge gap.

2.10. References

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Chapter 3

Vulnerability of British farms to post-Brexit subsidy removal, and implications for intensification, extensification and land sparing.

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This manuscript has been published in Land Use Policy and in Land Use Policy: Special issue on Public goods from agriculture and forestry

D.A. designed and conceived the research. D.A. conducted the analysis of the data and prepared the manuscript. All authors discussed results and contributed to preparation of the manuscript.

3.1. Introduction

On the 23rd June 2016, the UK referendum on European Union (EU) membership resulted in 52% of people voting to leave the EU (BBC, 2016). A departure from the EU would also see an exit from the Common Agricultural Policy's (CAP) support framework, the primary driver of UK agricultural policy for over forty years (Wallace and Scott, 2018). As a result, the UK could lose, or see to changes to, its trading relationship with the EU, be impacted by potential increases in trade tariffs and, because of proposed changes to agriculture policy, see the reduction, and ultimate removal of, the European Agricultural Fund (Pillar 1, also known as the Basic Payment Scheme (BPS); Gove, 2018; WG, 2018). Independent research studies, evaluating potential impacts of an EU exit on UK agriculture, present a range of projections varying between a 'business as usual', no tariff, deal and a no EU trade agreement where the UK moves to World Trade Organisation (WTO) rules and a Most Favoured Nation (MFN) status (AHDB Horizon, 2017; Dwyer, 2018; Helm, 2017). These studies make it clear that increased transaction costs, and the removal of Pillar 1 payments will place significant financial pressures on certain sectors of the industry, and this is likely to drive change in both farming practice and land use. A proposed transition period until 2022 and potentially beyond, albeit with alterations to payment methodology, will reduce the immediate impact (Gove, 2018). However, post 2022, UK agricultural policy will significantly differ to that of the CAP as its primary focus will be on the delivery of 'public goods for public money' (Defra, 2018a; WG, 2018). Whilst debate exists around the exact definition of 'public goods' (Cardwell and Smith, 2018; WG, 2018), both Gove (2018) and the Welsh Government (WG, 2018) recognise the contribution farmers make to food security, rural communities and valued landscapes. Consequently, proposals for future policy-based approaches appear to promote strong multifunctionality across the agricultural spectrum through the introduction of schemes which aim to target social, economic, cultural and environmental capital in a bid to keep farmers on the land, increase productivity and deliver a ‘green Brexit’ (Gove, 2018). In Wales, an ‘Economic Resilience’ scheme will aim to support primary production, processing and manufacturing, whilst a ‘Public Goods’ scheme will aim to reward farmers with payments for outcomes based upon the value society places upon them e.g., decarbonisation and climate change adaptation, resilient habitats and ecosystems, flood reduction, air and water quality and heritage and recreation (WG, 2018). This paper evaluates the extent of reliance upon Pillar 1 payments, across UK/Welsh farms and aims to identify numbers and types of farm holding potentially facing economic hardship and the areas of land and numbers of livestock associated with those holdings. Whilst previous analysis has undertaken similar estimations based on UK Farm Business Survey data, this analysis draws on figures from government agricultural statistics and rural payment divisions to provide a more comprehensive insight (Fig. 3.1).

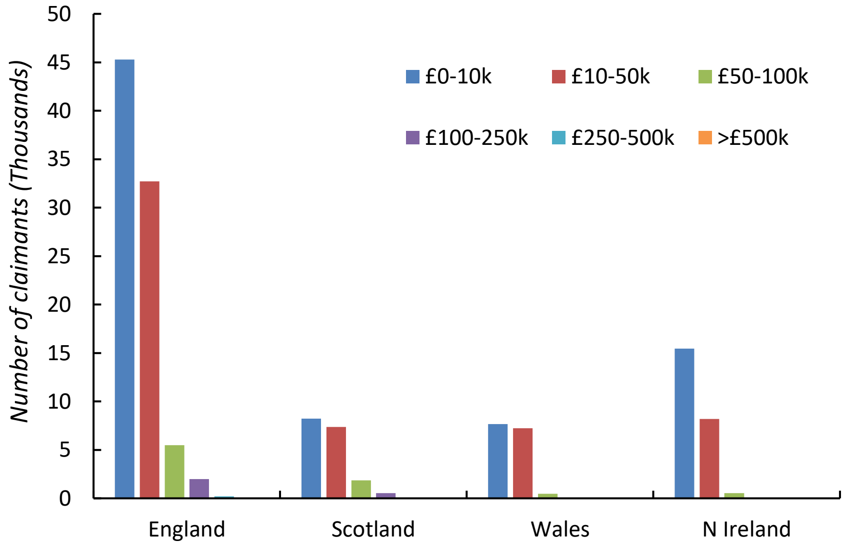

Figure 3.1. Pillar 1 (basic Payment Scheme + greening payment) claimants for 2017 by payment agency country of origin and payment bracket. Source: (Defra, 2017b).

Currently, England and each of the devolved nations, collect data on the financial, physical and environmental performance of farm businesses through June Agricultural Surveys and Farm Business Surveys (FBS). The June Agricultural Survey is the primary source for information about agricultural land, livestock and farm labour covering all known farms (annual sample c12,000; WG, 2017a), whilst the FBS collects detailed physical and financial information (annual sample c550-600 farms randomly selected from the June survey sample; WG, 2017b) for use by policy maker, researchers and farmers (Aberystwyth University, 2019). Farm business income (FBI), reported on in the FBS, is the difference between total output and total input and is the same as net profit. Four components of farming businesses - agricultural/standard output (standard output (SO)[3] used throughout this manuscript), the basic farm payment (BFP), agri-environment payment and diversification, such as letting of buildings for non-farming use, renewable energy generation, tourism and use of farm land for sport or recreation, provide the structure to FBI. Data collected on FBI enables benchmarking and the monitoring of changes to average farm income that occur over time. However, large farms receiving large Pillar 1 payments, can heavily skew average incomes, concealing considerable national variation in farm level incomes (WG, 2017a). Variation in payments exists both between and within farm types (Defra, 2017a; SG, 2018; WG, 2017b) making it difficult to predict the number of farms likely to be impacted by the removal of Pillar 1 subsidies using just FBS/FBI. This study, aims to remove some of this variation through an analysis of the CAP payments dataset (2017; Defra, 2017b) and a Welsh Statistical Office (WSO) dataset which combines June Agricultural Survey (WG, 2017a) with Rural Payments Wales (RPW) records for farms in receipt of Pillar 1 payments in 2017 (WG, 2017c). The results of this study are also used to explore the potential impacts that subsidy removal may have on land use in Wales.

[3] The standard output of an agricultural product (crop or livestock), abbreviated as SO, is the average monetary value of the agricultural output at farm-gate price. See https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Standard_output (SO).

3.2. Methodology

3.2.1. Farm holdings and land at risk

Farms most reliant on direct subsidies, were identified through an analysis of two of the four components of interest to the FBS, *viz*. SO and the BFP. These two components were selected as those most likely to change significantly post-Brexit. In order to identify Pillar 1 payment patterns across the UK analysis was conducted on both the 2016 and 2017 CAP payments dataset, published annually, in compliance with Regulation (EU) No 1306 (EC, 2013) and Commission Implementing Regulation (EU) No 908 (EC, 2014) (Defra, 2017b). No significant differences were found in the results for both datasets so here results are presented based on the 2017 dataset, thereby matching the data year for the WSO dataset. Whilst the CAP payments dataset provides payment data for all countries of the UK, information combining payments data with June Agricultural Survey data was only available from the Welsh Government's Agricultural Statistics Office. The WSO dataset is used to conduct a focused Wales-level study (WG, 2017c). Farms in the WSO dataset are classified by their economic size (SO), farm type (dominant activity on a farm spilt into five categories, listed below), area of land (survey estimate excluding the use of common land), and sum of Pillar 1 payments. The farm population (n = 24,492) used in the WSO dataset equates to 70% of the total farm holdings in Wales (n=35,300; WG, 2017a) and includes all 'active' farms excluding:

- Cross border farms that are paid by Defra rather than Rural Payments Wales (RPW).
- All claimants paid by RPW that do not have a Welsh County Parish Holding (CPH) number. (Farms are required to have a CPH number if they wish to keep farm animals or apply for an agricultural subsidy).

- Any other claimants known from RPW but with no link to the Welsh Agricultural Survey i.e., holdings with little or no agricultural activity and those that specialise in pigs and/or poultry.

This study focuses on five farm type categories, namely:

i) Grazing livestock - Severely Disadvantaged Areas (SDA)*

ii) Grazing livestock - Disadvantaged Areas (DA)*

iii) Other grazing

iv) Dairy

v) Other farm types (Horticulture, cereals, pigs, poultry, etc.).

* *SDA/DA land is generally suitable for extensive livestock production and for the growing of crops for feed, but agricultural production is restricted/severely restricted, by soil, relief, aspect or climate conditions (WG, 2014).*

A payments distribution analysis of the 2017 CAP payments dataset (Defra, 2017b) was utilised to identify Pillar 1 payment distribution patterns across the UK paying authorities. The CAP payments dataset (Defra, 2017b) provides data on the number of claimants of Pillar 1 payments, and the Agriculture in the United Kingdom 2017 report provides data on the total number of agricultural holdings per country (Defra; DAERA; Welsh Assembly Government and The Scottish Government, 2018). Difficulties arise in the accurate identification of non-claimants in England, Scotland and Ireland, as many claimants listed in the CAP payments dataset are companies or estates claiming for more than one holding. However, in Wales, the identification of non-claimants is made more accurate through the use of the WSO dataset and CPH numbers.

A cross tabulation analysis of the SO and payment brackets of the WSO dataset provided a more detailed assessment of the number of Welsh holdings likely to be financially at-risk following Pillar 1 subsidy removal. Within the WSO dataset, SO brackets are expressed in Euro (€) and payments amounts in GBP (£). For analysis and continuity, Euro (€) was converted to GBP (£) and this manuscript shows SO in both GBP (£) and Euro (€). Farms are defined as being potentially at financial risk following direct subsidy removal if direct payments are reasonably high in comparison to their economic size. In the category of farm holdings receiving <£10k in direct payments, all farms of a small economic size i.e., with a SO <£23,400 (€25k) are classed as being at risk in this category as payments received can be equivalent to nearly half of the total agricultural income of the farm, suggesting a high dependency on direct payments. Given that the median payment for Welsh farmers receiving <£10k is £4,171 (Defra, 2017b) and that, on average, farms need to reduce costs by 11% in order to break even without direct payments (Defra, 2018b), farm holdings of a higher economic size i.e., with a SO >£23,400 (€25k) are not included. The caveat to the analysis above is that, whilst it cannot be guaranteed that all farms with a SO >£23,400 (€25k) and a direct payment <£10k would survive following subsidy removal; they are more likely to be able to make efficiency cuts to compensate for loss of payments. In the £10-20k and £20-40k payment brackets, all farms of a small economic size i.e., SO <£23,400 (€25 k) and some farms with a medium economic size i.e., SO £23,400 (€25 k) - £107k (€125k) are likely to be highly dependent on direct subsidies. To err on the side of caution, all farms with an SO <£23,400 (€25 k) and an SO of £23,400 - £107k (€25-125k) are included in the estimate of farms at financial risk following subsidy removal. Farms of a high economic size i.e., SO >£107K (€125k) - £215k (€250k) and very high economic size i.e., >£215k (€250k) were removed as they are more likely to be able to make efficiency cuts to compensate for loss of payments. In the payment bracket ≥£40k, all farms of a small economic size i.e., those with a SO <£23,400 (€25 k) and some farms with a medium economic size i.e., SO £23,400 (€25 k) - £107K (€125k) are likely to be highly dependent on direct subsidies. Erring on the side of caution, all farms with a SO of £23,400 (€25 k) - £107K (€125k) are included in the estimate of farms at financial risk following subsidy removal. Ninety-seven farms have a high economic size i.e., SO >£107K (€125k) - £215k (€250k) and 123 have a very high economic size i.e., SO >£215k (€250k), of these, 67 claimants receive Pillar 1 payments >£100k (0.2% of total farm holdings in Wales). These are all large farms and many have very high SO and are likely to be able to reduce costs or absorb the loss of direct payments. Due to the low number of farms impacted at this level we do not include farms with a >£107K (€125k) in our 'at risk' category.

Whilst this study does not consider the impact of a no trade deal on farming sectors, it is felt that the analysis of the WSO dataset, which combines SO and BFP through the use of CPH numbers, eliminates some of the variation surrounding average Pillar 1 payments and FBI found in the FBS. This allows a more precise identification of those most likely to feel the impact of subsidy removal, allowing for a focused targeting of support, be it 'public goods' funding or support for sustainable production.

3.2.2. Livestock held on at risk farms within Wales

The WSO dataset contains data on stocking levels taken from the June Agricultural Survey (WG, 2017a). Cross-tabulation is used to identify the total number of beef cows and sheep by payment categories and grazing farm types. The total number of cows and sheep are divided by the total number of farm holdings to provide an average livestock holding per farm holding within each category. The average livestock holdings for both beef cows and sheep are multiplied by the farm holdings identified at risk in each of the categories to give an estimated total number of beef cows and sheep held on at risk holdings.

3.3. Results

3.3.1. UK Pillar 1 payment distribution

Average income data (DAERA, 2018; Defra, 2017a; Scottish Government, 2018; Welsh Government, 2017a), across the four components of interest for farm businesses, for less favoured areas (LFA) and lowland cattle and sheep farms show average BPS and agri-environment payments constituting a large proportion of FBI (Table 3.1). For example, in Wales, in the case of LFA cattle and sheep farms > 60 % either make a loss or would have made a loss without subsidy (WG, 2017b). In 2017, the total number of agricultural holdings in the UK was ~217,300 (DAERA; Defra; Scottish Government and the Welsh Assembly Government, 2018) and there were 143,385 claimants of Pillar 1 payments.

Table 3.1. Summary of farm business statistics for cattle and sheep farms in less favoured areas (LFA) and Lowland areas across UK for the 2016-17 accounting year.*

Income by cost centres	Cattle and sheep (LFA) Average per farm (£)				Cattle and sheep (lowland) Average per farm (£)			
	England	Scotland	Wales	N. Ireland	England	Scotland	Wales	N. Ireland
Agriculture	-9,400	-24,409	-6,200	-10,674	-8,700	-19,376	4,100	-7,847
Basic / single farm payment	22,800	40,867	21,000	32,027	15,300	31,905	14,100	24,424
Agri-environment	11,200	13,825	5,600		3,000	2,360	1,600	
Diversification/contracting	2,400	13,825	2,700		6,500	3,363	3,000	
Total farm business income	27,000	35,284	23,100	21,352	16,100	18,253	22,700	16,578

* Source: (Defra, 2017a; Welsh Government, 2017a; DAERA, 2018; Scottish Government, 2018).

Table 3.2 provides a breakdown of the total farm holdings and the total number of claimants in each of the countries of the UK. Variation exists between the countries when comparing the proportion of claimants to the total number of holdings. Some claimants in each country will be estates or companies claiming for more than one holding but many will be non-claimants. Farmers must have at least 5 ha of eligible land to claim BPS, and must either; produce, rear or grow agricultural products (including harvesting, milking, breeding animals and keeping animals for farming purposes) or, keep some land in a state suitable for grazing or cultivation by keeping it clear of scrub that cannot be grazed (RPA, 2018).

Table 3.2. The total number of farm holdings and claimants of Pillar 1 payments by Country of paying authority.*

Country	Number of holdings	Number of claimants
England	106,000	85,734
Scotland	51,000	17,990
Wales	35,300	15,431
Northern Ireland	25,000	24,230
Total	217,300	143,385

* Source: (Defra, 2017b; Defra; DAERA (Northern Ireland); Welsh Government, and the Scottish Government. 2018)

Payment distribution patterns for those claiming Pillar 1 subsidies are similar across all of the devolved administrations with the greatest proportion of claimants in each falling in the £0-10k bracket (61% N. Ireland; 46% Scotland; 50% Wales and 53% England) with a UK median of £3,505 for those in this payment bracket. In fact, 39% in N. Ireland, 33% in Scotland, 29% in Wales and 35% in England claim <£5k, with a UK median of £2,310 for those in this payment bracket. Detailed information linking this payment data to farm structure and income data was not available for England, Scotland and Northern Ireland, but the similarities in the payment structures of the four UK countries shown in this analysis, suggests the results of this focused study of Wales will have relevance across the whole of the UK.

3.3.2. Wales as a focus area to identify vulnerabilities post-subsidy removal

The total WSO dataset population used in this focused study (n = 24,492) represents 70% of the total farm holdings in Wales (n=35,300; WG, 2017a). However, the sample farms represent ~93% of the total agricultural land held on Welsh holdings in 2017 (1,686,700 ha; WG, 2017a) and ~100% of the estimated sheep and 80% of the estimated beef holdings in Wales, 2017 (WG, 2017a). Therefore, this sample is likely to be indicative of what would happen across a large portion of the Welsh farming sector, and relevant to other UK countries (due to similarities in payment structures). Of the total population surveyed, 11,809 (48%) were non-claimants of Pillar 1 payments showing that, despite some estates and companies claiming for more than one holding, there are high levels of farm holdings with no reliance on Pillar 1 payments.

3.3.3. Farm holdings assessed to be at financial risk

Analysis found the total holdings potentially at financial risk, should direct support payments be removed and not be replaced by support mechanisms of a similar amount, as being 8,328 (~34% of the total sampled population). It is estimated that 4,030 SDA (54% of the total sampled SDA population), 2,188 DA (51% of the total sampled DA population), 1,059 other grazing (43% of the total sampled other grazing population), 80 dairy (5% of the total sampled dairy population), and 971 other farm types (11% of the total sampled other farm type population) are potentially at risk. Table 3.3 gives a detailed breakdown of holdings at risk by farm type and payment bracket.

Table 3.3. Summary of the number of Welsh farm holdings and their land area (ha), assessed to be at risk from subsidy policy change, classified by subsidy payment bracket and Severely Disadvantaged Areas (SDA) grazing; Disadvantaged Areas (DA) grazing; other grazing; dairy and other farm types.

Farm type	SDA grazing		DA grazing		Other grazing		Dairy		Others		
Payment bracket	No of claimants	Land area (ha)	No of claimants	Land area (ha)	No of claimants	Land area (ha)	No of claimants	Land area (ha)	No of claimants	Land area (ha)	Totals
Under £10k	1,239	27,189	1,090	24,701	511	11,490	25	458	602	14,137	
£10-20k	1,437	152,188	788	81,515	415	42,156	53	3,598	282	26,202	
£20-40k	1,027	173,563	273	41,648	122	19,718	2	77	67	9,776	
≥£40k	327	54,818	37	5,071	11	1,493	0	0	20	2,537	
Total number of holdings at risk	4,030		2,188		1,059		80		971		8,328
Total land area at risk of change (ha)		407,758		152,935		74,857		4,133		52,652	692,335

Table 3.4. Summary of Welsh Severely Disadvantaged Areas (SDA) grazing; Disadvantaged Areas (DA) grazing; other grazing; dairy and other farm types assessed to be at risk from subsidy policy change and the total livestock holdings facing potential displacement per payment bracket.

Farm type	SDA grazing			DA grazing			Other Grazing			
Payment bracket	No of Claimants	Total beef cows	Total sheep	No of claimants	Total beef cows	Total sheep	No of claimants	Total beef cows	Total sheep	Totals
Under £10k	1,239	2,610	156,399	1,090	4,269	27,279	511	1,860	14,186	
£10-20k	1,437	13,408	986,271	788	13,247	343,626	415	6,311	143,774	
£20-40k	1,027	16,945	1,086,983	273	7,344	183,412	122	3,334	51,344	
≥£40k	327	6,199	350,468	37	1,060	21,393	11	77	9,319	
Total claimants	4,030			2,188			1,059			7,277
Total beef cattle		39,161			25,920			11,582		76,663
Total sheep			2,580,120			575,710			218,623	3,374,453

3.3.4. Land area associated with at-risk holdings

The WSO dataset (WG, 2017c) gives area of land per farm (ha) based on agricultural survey estimates (WG, 2017a) excluding the use of common land. The 1,571,593 ha of agricultural land covered by the dataset represents 93% of the total agricultural land, excluding common land, held on Welsh holdings in 2017 (1,686,700 ha; WG, 2017a). The total land is distributed between the following farm holding categories, SDA holdings (793,418 ha), DA holdings (231,465 ha), other grazing (124,327 ha), dairy (218,911 ha) and other farm holding types (203,471). Using these estimates, the total land held on at-risk farm holdings is identified as being 692,335 ha (~44% of the land covered by the dataset[4], table 3). This equates to; 51% of the total land held on sampled SDA holdings (407,758 ha), 66% of land held on sampled DA holdings (152,935 ha), 60% of land held on sampled other grazing holdings (74,857 ha), 2% of land held on sampled dairy holdings (4,133 ha) and 26% of land held on sampled other farm holding types (52,652 ha).

3.3.5. Threat assessment (Beef and sheep sector)

SDA and DA land are predominantly associated with sheep and beef grazing farms. The total number of sheep (n = 10,017,323) and the total number of beef cows (n = 167,500), covered by the WSO dataset (WG, 2017c) used in this study, equates to ~100% of the estimated sheep and 80% of the estimated beef holdings in Wales, 2017 (WG, 2017a). Approximately 3.4 million sheep and ~77,000 beef cows are estimated to be currently grazed on land deemed at risk from subsidy policy change (Table 3.4). This represents 34% of the total sheep flock and 46% of the beef herd covered by the dataset.

[4] Total percentage breakdown does not add up to 44% due to rounding up and down.

3.4. Discussion

This study estimates the potential impact of Pillar 1 subsidy removal in isolation from potential trade scenarios. Predictions made are estimates of farm holdings potentially at financial risk should Pillar 1 payments be removed and not be replaced by an alternative income source delivering similar amounts. There are some limitations to the approach and this interpretation, as it is not possible to make individual financial assessments, including off-farm and diversification income for each farm. However, the ability of the Welsh Government's Agricultural Statistics Office to create a dataset that combines farm data with rural payments has allowed this study to present a much more comprehensive 'actual' picture of business reliance across Wales than FBS averages. The June Agricultural Survey, when viewed in isolation, provides estimates for land use, livestock and labour on Welsh farms (WG, 2017a), but this use of combined datasets enabled the area of land and grazing livestock associated directly with farm holdings vulnerable to change to be identified. This ability to view a more comprehensive picture of vulnerabilities within the agricultural landscape of Wales allowed the exploration of potential impacts of change. The scale and speed at which proposed change may occur means that many businesses will need to adapt quickly and change some aspect of their operations to remain viable (WG, 2018). This in turn may drive land-use change (Terres et al., 2015; van Vliet et al., 2015), viz. some farmers will consider taking on increased environmental responsibilities (Burton, 2014; Forney, 2016; WRO, 2010), some will diversify or seek other forms of income (WG, 2017b; WRO, 2010) and some will de-intensify or downsize the farm business (WRO, 2010). In contrast, some may look to intensify production to compete against a potential influx of large overseas agribusiness companies (Foote et al., 2015; Mansell, 2017). Both ends of the spectrum have been posed in debates and below this analysis reflects on how extremes of intensification (expansion) or extensification (contraction) of agricultural land or practices (van Vliet et al., 2015) could impact upon land use in Wales.

The use of land sparing strategies, where some land is set aside for conservation while other land is used intensively to produce agricultural commodities (Fischer et al., 2014), is explored as an alternative to the extreme.

3.4.1. Intensification

Intensification of agricultural land primarily manifests itself as an increase in land management intensity (van Vliet et al., 2015). Technological, institutional and location factors (Latruffe et al., 2013; van Vliet et al., 2015) combined with farmer characteristics, in particular the productivist attitude of farmers (Hardaker, 2018; Hyland et al., 2016; Wynne-Jones, 2013), and the household economic conditions of the farming family (Latruffe et al., 2013; van Vliet et al., 2015) drive the intensification decision-making process. Here it is shown that ~34% of sampled farmers in the dataset potentially face financial hardship following subsidy removal. These changes in economic conditions, when combined with changes to agricultural land values, may be a major driver of land use change. Links between land value and price support systems means changes in UK agricultural policy will likely affect land prices, resulting in both winners and losers in the sector (Roberts, 2018). In Wales, this means landowners and managers, of the ~44% of sampled agricultural land we show to be on holdings potentially facing financial hardship, will have to make decisions that impact upon farm survivability. Falling land prices or agricultural product prices, combined with the loss of payments, may drive already struggling businesses to collapse (Dwyer, 2018). Whilst this may create opportunities for new entrants to the sector (Roberts, 2018) and other kinds of buyer (forestry, leisure and tourism, environmental NGOs; Dwyer, 2018) it may also encourage an influx of foreign direct investment, including investment by foreign agricultural businesses (Mansell, 2017). UK farm business consolidation may increase and become more intensive as a way to compete against large overseas agribusiness companies and this is likely to have an adverse environmental impact (Baldock et al., 2017; Barnes, 2016: Foote et al., 2015). These findings for Wales show some similarities in direct payment schemes with New Zealand, pre-subsidy removal (Federated Farmers of New Zealand, 2002), with sheep and beef farmers having a higher reliance on direct payments than other sectors. In New Zealand, immediately following subsidy removal, hill country sheep and beef farmers suffered severely, while for dairy, horticulture and cropping units the impact was generally slight (Smith and Montgomery, 2004). As a result, dairy farming intensified and expanded dramatically whilst sheep and beef sectors declined (Federated Farmers of New Zealand, 2002; Foote et al., 2015; Smith and Montgomery, 2004). With larger areas of cropland and grassland (DAERA; Defra; Scottish Government; and the Welsh Assembly Government, 2018). England may be more vulnerable to an increase in intensive practices than the other UK countries; however, in Wales levels of intensification found in New Zealand are unlikely, predominantly due to land limitations. Most of Wales is hilly or mountainous and this, combined with relatively poor soil quality and a wet climate, means most of the agricultural land is restricted to the grazing of sheep and cattle (WG, 2017a). There may be opportunities for potential intensification via transfer into dairying, and an increase in beef production (Dwyer, 2018) on grazing land not in SDA's or in less marginal areas but, for grazing livestock farmers at risk in the SDA's, the availability of a new sustainable land management scheme may present the greatest opportunities to maintain viability through increased extensification.

3.4.2. Extensification

Our study shows that without intervention to support vulnerable businesses, it is likely that ~34% of Welsh farmers will struggle to remain viable. Previous studies of farmers in the UK and across the EU suggests 9 – 20%, would consider leaving farming if direct payments were to be reduced (Barnes et al., 2016; Latruffe et al., 2013; Raggi et al., 2013; WRO, 2010; 2013), but their decision to do so would be based on several factors. Natural and economic conditions surrounding the farm play a crucial role in its survival and therefore farm location will potentially force a decision to leave (Latruffe et al., 2013). Farmer age (Latruffe et al., 2013; Raggi et al. 2013) and the identification of a successor (Barnes, 2016; Lobley and Butler, 2010) also have key roles in the decision-making process. In Wales, the median age of farmers is 61.2 years old (WG, 2016), only 60% of farmers have a successor (WRO, 2010) and of those identified as most vulnerable in this study, 36% are SDA and DA sheep and cattle farmers. Whilst exit rates of Welsh farmers cannot be accurately predicted, it is likely that this group of farmers are those most likely to consider an exit strategy, potentially releasing agricultural land to the open market (WRO, 2010; 2013; Barnes et al., 2016). In some areas, this release of land may lead to an increase in “ranching” as a way of managing land and stock, with control of the land shifting to the control of fewer farmers with larger farms (Barnes, 2016; Baldock et al, 2017; Dwyer, 2018). In other areas, this may result in destocking or land abandonment, a process ‘whereby human control over the land (e.g. agriculture, forestry) is given up and the land is left to nature’ (FAO, 2006), especially in hill areas if there is little or no viable return from sheep farming (Acs et al., 2010; Terres et al., 2015; WG, 2017d). The resulting externalities can be both positive and negative (Lasanta et al., 2017; Levers et al., 2018). Whilst abandonment can occur anywhere (Terres et al., 2015), recent European studies have shown agricultural abandonment primarily occurring in less productive areas, remote and mountainous regions (van der Zanden et al., 2017). In Wales, 75% (~1.3 million ha) of agricultural land is categorised as disadvantaged upland habitat (SDA or DA; AHDB Horizon, 2018). This study estimates ca.560,700 ha (~43% of the total upland habitat) of land to be on SDA or DA grazing livestock holdings potentially facing financial difficulties as a direct result of Pillar 1 subsidy removal. In addition, there are ~180,300 ha of common rough grazing currently managed by SDA/DA grazing livestock farmers. This combined with the limited scope to change farming practices, make the upland habitats of Wales particularly vulnerable to abandonment.

Whilst agricultural policy change is inevitable, the potential negative social, economic and environmental impacts of abandonment must be of concern to policy-makers (Moravec and Zemeckis, 2007). Agricultural abandonment can lead to a loss of farmland biodiversity (Beilin et al., 2014; Renwick et al., 2013) and cultural landscapes (Navarro and Pereira, 2015) and drive rural redeployment (FAO, 2006), all of which have the potential to radically change upland landscapes and communities in Wales. Climate change projections which predict increased warming, droughts and drier summer conditions (EEA, 2016) increase the risk of wildfires in upland habitats, especially in degraded peatland areas (Longlands and Hunter, 2018). These risks are amplified if land management practices such as agri-support (Gazzard et al., 2016) and peatland management schemes (Turetsky et al., 2015), which currently help mitigate against fire risk (Longlands and Hunter, 2018), are reduced due to land abandonment. However, there are counter arguments that highlight positive benefits associated with land abandonment. These include improvements to non-provisioning ecosystem services such as carbon sequestration (Munroe et al., 2013), the beneficial restoration of non-agricultural habitats (Keenleyside and Tucker, 2010), and improved soil recovery and nutrient cycling (Benayas and Bullock, 2015). There are also opportunities to reduce GHG emissions through a reduction in livestock production in Wales (because of land abandonment; MacMillan and Beeden, 2016), however there is also potential for C leakage, if the reduction in agriculture production is accommodated elsewhere in the UK/EU/World (Herrero, et al., 2016).

Our findings from Wales, show similar spatial patterns to Renwick et al. (2013) who found policy change mainly affecting farmers in upland habitats, which also coincide with areas of high nature value. Managing the potential multiple impacts of land use change in these upland areas will involve the use of trade-offs assessments, between socio-economic, cultural and environmental options, if strategies are to achieve multiple objectives (van der Zanden et al., 2017). Proactive land management may help mitigate against the negative externalities associated with land abandonment creating a situation where the delivery of positive 'Public Goods' benefits can be maximised. Sustainable land management strategies must account for spatial differences between agricultural lands that may support intensification and those that underpinned by differential potential to deliver particular ecosystem services if policies are to deliver on both food security and environmental objectives. On-or-off farm diversification provides opportunities for farm business to increase viability. Previous studies (WG, 2017b; WRO, 2010) show 38-50% of farms receiving income through diversification activities, with the Welsh FBS showing the proportion of farms with any type of diversified activity increasing each year from 2010-11, to 2016-17. In this study, it is assumed that there will be no decrease in diversification income and that future diversification activity will only lead to increases in farm business income.

3.4.3. Land sparing as more targeted land management strategy

This study shows that abandonment is quite likely in some instances, as intensification is less likely to happen in very marginal areas, thus highlighting some of the social and ecological consequences associated with land use change. Marsden et al. (2015) also identify the need for a more cohesive and integrated approach to sustainable land management across the protected landscapes of Wales (Areas of Outstanding Natural Beauty and National Parks), if the government is to effectively resolve the more complex issues currently facing rural areas of Wales. An exit from the EU provides policy-makers, through future agricultural policy, with a unique opportunity to shape the future of the agricultural landscape using strategies that manage production, mitigate against the ecological and social risks of changing land use and ensure the survival of cultural heritage.

Governments aiming to meet increasing food demand while delivering other ecosystem goods and GHG reductions, will require farmers to produce food as sustainably possible on the most productive land available, so that more natural habitats can be “spared from the plough” (Balmford et al., 2018). Indeed, high yield farming coupled with land spared for increased carbon sequestration, could result in agricultural greenhouse gas emissions being offset by the increase in carbon stored (Lamb et al., 2016). However, others argue that the land sharing/land sparing dichotomy is too simplistic (Jiren et al., 2018) and has limited value because existing patterns of land use are more heterogeneous (Herzog and Schüepp, 2013). Loos and von Wehrden (2018) argue that given population size and considering that few untouched natural areas remain within Europe, there is no alternative to sharing land already used by agriculture. The land sharing/land sparing debate clearly puts two important objectives on the agenda: biodiversity conservation and agricultural production (Herzog and Schüepp, 2013). These objectives are undisputable, as there is a simultaneous need to produce more food for a growing population, provide economic opportunities for those who depend on agriculture for their livelihoods, and reduce environmental impacts, including ecosystem degradation and high greenhouse gas emissions (Searchinger, 2014). It may be that the overarching goal of sustainably delivering social, economic, environmental and cultural objectives cannot be broken down to a single management decision such as ‘sharing or sparing’ and that a more balanced approach, using the principles of sparing, could provide a solution (Herzog and Schüepp, 2013). At risk, upland farmers are unlikely to be financially viable, as food producers, without some form of support (Dwyer, 2018) whilst, at risk lowland farmers have the potential, with support, to sustainably intensify production. The opportunity therefore exists to look at forms of ‘sparing’ within the agricultural landscape to simultaneously, increase production, deliver environmental outcomes and provide farmers with an income stream, retaining them on the land and mitigating against the social and ecological risks associated with land abandonment and intensification.

Upland farmers could receive payments to maintain cultural and spiritual ecosystem services, promoting the ‘Cymru Wales’ national brand (WG, 2018; WG, 2019b) and working with the government to improve the condition of the protected landscapes of Wales (Marsden et al., 2015) and deliver high quality, targeted, ‘public goods’ at a landscape level. The collaborative spirit in the supply chain, required to increase market potential (WG, 2108a), could potentially be achieved in this area through National Park Authorities supporting farm diversification and the promotion of produce which supports brand promotion. Under these scenarios, the use of livestock as a tool to maintain habitats helps retain cultural heritage, provides additional income streams and potential access to both the sustainable farming and business support payments being offered by the proposed Welsh Government’s Sustainable Farming Scheme (WG, 2019b).

Access to support provided through business support payments (WG, 2019b) will allow more productive ‘other grazing’ (i.e., not SDA/DA) and ‘other farm types’ to ‘sustainably intensify’, that is, increasing agricultural output while keeping the ecological footprint as small as possible (Rockström et al., 2017). These farmers, through sustainable agricultural practices in more productive landscapes, can also contribute to the sustainable ‘Cymru Wales’ national brand whilst providing the necessary outcomes required to deliver the government’s vision to have land managers delivering both public goods and sustainable food security. Increased productivity on less land through the implementation of sustainable intensification strategies in these more productive landscapes will potentially ‘spare’ land to enable access to the Public Goods scheme.

3.5. Conclusion

This paper has focussed on the potential impact of Pillar 1 subsidy removal on the farming community, with a particular focus on impacts in Wales. Access to Welsh Statistic Office and Common Agricultural Policy datasets (Defra, 2017b; WG, 2017c) enabled the identification of vulnerabilities within farming communities, post-subsidy removal. Holdings in either Severely Disadvantaged Areas or Disadvantaged Areas potentially face the highest levels of financial difficulty and are the most vulnerable to land use change. This approach has presented a more comprehensive picture of farm holdings, land areas and livestock numbers at risk from direct subsidy removal than the averages presented in Farm Business Surveys. Based on the results an evaluation of the potential social and ecological impacts that subsidy removal may have on land use in Wales was conducted. This evaluation identified opportunities to implement a more balanced approach to land management, based on sustainable intensification and land sparing principles that could support governmental visions (Defra, 2018a, WG, 2018; WG 2019) to keep farmers on the land, improve productivity and provide environmental benefits.

These findings support the Welsh Government's Sustainable Land Management approach as means to reduce risk and deliver social and ecological benefits. However, given the size of the challenge, it is questioned whether funding levels, post-Brexit, will be enough to mitigate against all the social and ecological risks identified in this paper. Further research is required to measure the impact UK-wide, but similarities in the payments structures suggests there is potential to extend this strategy across areas of England, Scotland, and Northern Ireland with similar demographics of farm typologies. This study has not addressed the subject of future trade deals with the EU and other nations and a potential move to WTO tariffs. However, an increase in transaction costs, as result of a no trade deal, is only likely to intensify the pressures on SDA/DA farmers (Dwyer, 2018) and make the possibility of a land sparing strategy more attractive.

Acknowledgements

This work was supported by the FLEXIS (Flexible Integrated Energy Systems) programme, an operation led by Cardiff University, Swansea University and the University of South Wales and funded through the Welsh European Funding Office (WEFO). We thank Stuart Neal and the Welsh Government's Agricultural Statistics Office for data provision and advice.

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Chapter 4

What can management option uptake tell us about ecosystem services delivery through agri-environment schemes?

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This manuscript has been published in Land Use Policy

D.A. designed and conceived the research. D.A. conducted the analysis of the data and prepared the manuscript. All authors discussed results and contributed to preparation of the manuscript.

4.1. Introduction

The ‘sustainable growth: natural resources’ category funds the Common Agricultural Policy’s (CAP) two payment streams (Keep, 2017). First, is the European Agricultural Guarantee Fund (EAGF) (Pillar 1) which makes payments directly to farmers, and funds measures to regulate agricultural markets, and second, is the European Agricultural Fund for Rural Development (EAFRD) (Pillar 2) which aims to develop rural economies and increase the productivity of farming and forestry. As a direct result of the 23rd June 2016, UK referendum on EU membership, the UK payment structure is facing reform and is likely to move away from this two Pillar structure (Helm, 2017; Dwyer, 2018; Gove, 2018). Future financial support is expected to pay farmers to deliver clear environmental or ‘public good’ benefits rather than through direct payments (Gove, 2018; WG, 2018). In the EU, an average of 16.8% of the EAFRD is spend on Agri-Environment-Climate contracts but in the UK, this currently varies between the devolved nations (Gravey, et al., 2017). The Welsh Government (WG) views agri-environment schemes (AES) as, “the state … buying environmental goods and services (Public Goods) from farmers who would otherwise not supply them” (Rose, 2011). This would suggest, that in Wales, structures are in place to meet the UK government’s challenge (Gove, 2018) to enhance our natural environment and hand on a country, and a planet, in a better state than we found it. The current ‘action-based’ AES schemes, employed across the UK to deliver environmental outcomes, include a suite of land management ‘options’, designed to ensure the availability of suitable options, across all land types, within the remit of the particular scheme (Rose, 2011; Munday, 2018). However, the prescriptive nature of this type of scheme is often seen as a barrier to scheme uptake (Wilson and Hart, 2000) and long-term behaviour change (de Snoo et al., 2013). The cost-effectiveness (Ansell et al., 2016), and ecological impact of this type of 'action based' AES, on birds (McHugh et al., 2016; Princé et al., 2012; Sabatier et al., 2012: McHugh et al., 2016), insects (Wood et al., 2015; Caro et al., 2016) and biodiversity (Kleijn and Sutherland, 2003; Kleijn et al., 2006; Fuentes-Montemayor et al., 2011; Wilkinson et al., 2012; Ekroos et al., 2014) is also widely debated in the literature. Many suggest schemes which link payments to the provision of desired environmental outcomes, rather than to prescribed management activities, could represent a more effective way of rewarding farmers for the delivery of "Public Goods" (Matzdorf and Lorenz, 2010; Sabatier et al., 2012; Moxey and White, 2014; Russi et al., 2016). It is also argued that 'results-based' schemes are more effective at enhancing social capital (Burton and Schwarz, 2013) and redirecting much needed funding to marginal upland, and some lowland areas, where income streams are low (Helm, 2017). Current studies consider the advantages, and disadvantages of both action, and results-based AES, in determining effectiveness but we found none that focus on the impact that option uptake and payment distribution may have on effectiveness.

This present study, aims to determine if current action-based AES are an effective means of delivering ecosystem services, using Wales as a study area. This is achieved by using secondary data analysis techniques to unravel the complexities of AES funding distribution and scheme structure, and GIS to explore the spatial scale and uptake of AES management options. The findings are used to establish if the payment distribution and option management structures of AES, currently funded through the CAP, provide effective ecosystem services delivery, or additional income support streams for farmers in low production areas. In conclusion, suggestions are made on how a UK exit from the EU can provide policy-makers with the opportunity to design AES which can effectively deliver '"Public Goods"' whilst subsequently providing farmers with the additional human and social capital needed to fully support social, economic and cultural objectives in Wales.

4.2. Methodology

4.2.1. Study area

Wales was selected as the case study area for its focus on sustainability (WG, 2015a; WG, 2016a; WG, 2017a), and for the following reasons: (i) agriculture being the dominant land use (84% of the total land area of 2.1 million ha; WG, 2017b), (ii) the proportion of famers who participate in AES (in 2017, 4781 farmers received AES payments, representing 13% of the total number of holdings in Wales; Defra, 2017b), (iii) the low average income of most farmers and their reliance on Direct and AES payments (62% of cattle and sheep farms (less favoured area, LFA) either made a loss or would have done so without subsidy, compared with 41% of cattle and sheep (lowland) farms and 44% of dairy farms; WG, 2017c), (iv) amount of land (0.8 million ha) being in higher or entry level AES (JNCC, 2017a), and (v) the availability of reliable AES data.

4.2.2. CAP payments data

Secondary data analysis techniques were used to identify the extent, and distribution, of current spending on agri-environment schemes (Johnston, 2014). The 2015/2016 CAP payments datasets, published for transparency by Defra (2017b) in compliance with Regulation (EU) No 1306 (EC, 2013) and Commission Implementing Regulation (EU) No 908 (EC, 2014), were used as the primary data source. Produced for accountability at both UK and EU governmental levels, these datasets are an accurate reflection of spending on rural development (Pillar 2) in the UK.

The dataset variables include funding categories, payment beneficiaries and total farm payment received. Agricultural production, social, agri-environment and support and forestry, target area variables are created and funding categories are assigned to the relevant target area based on descriptions found in Wales' 2014-2020 Rural Development Programme (WG, 2017d). Funding category payments are summed in each focus area giving total expenditure per target area category and expressed these as a percentage of total Pillar 2 expenditure. Total AES expenditure is expressed as a percentage of total Pillar 2 and of total CAP expenditure. The total number of recipients receiving financial support through both Pillar 1 and Pillar 2 payments and those receiving payments for agri-environment were collated to quantify the percentage of ‘active farmers’ enrolled in AES.

Payments were collated by postcode prefix (first two letters (postcode area) = postal town/ postcode district; number following postcode area = location within the postal town boundary) and a detailed analysis was conducted to identify the total number of recipients, the total payment per district and the mean farm-level payment. The total number of payment recipients and the total payments expenditure within the postcode district was expressed as a percentage of the total recipients and expenditure across Wales. Sixteen payments categories in the range £0-400k recipient^{-1} were generated and the total number of recipients and total payments made identified in each of the payment ranges.

4.2.3. Glastir AES data

The Glastir AES provides financial support to farmers and land managers to promote sustainable land management (Rose, 2011). Rural Payments Wales (2017) provided anonymised ESRI ArcInfo polygon shapefiles, mapped to OS Mastermap features at a 1:10000 scale, for the Glastir Entry (GE), Glastir Advanced (GA), Glastir Commons (GC), Glastir Woodland Creation (GWC) and Glastir Woodland Restoration (GWR) elements for the years 2015 and 2017. The first 5 year Glastir contracts started on 01st January 2012 and ended on 31st December 2016 (WG, 2012). Access to both the 2015 and 2017 datasets allowed for comparisons between option uptake pre and post the end of the first 5-year contractual period. Datasets for the Glastir Efficiency Grants (GEG), Glastir Organic (GO) and Glastir Small

Grants (GSG) were not available. A full description of the Glastir AES elements is provided in Appendix A.

Natura 2000 (NRW, 2015) apportions Glastir management options to land management categories (Habitat, Tree, Infrastructure and access, Water and drainage, Stock, Wildlife, Agri-management, Vegetation and birds). In this study, management option descriptions are extracted from the RPW attributes data (RPW, 2017) and grouped by Natura 2000 management categories. The total number of management contracts awarded are used to identify the most popular 15 options, and the most prominent management categories, for GA and GE. Appendix B contains further details on the breakdown of each of the management categories. ArcGIS-ArcMap 10.4.1 (ESRI, 2017) was employed to conduct a spatial analysis of the options data using overlay and geoprocessing techniques. Comparisons were made with the Predictive Agricultural Land Classification (PALC) Map 2017, designed on a 50 m raster (1:50,000) (WG, 2017e) and the Habitat Land Cover Map 2015 (LCM, 2015; CEH, 2017) supplied as a vector product with a minimum mappable unit of 0.5 ha and a minimum feature width of 20 m.

4.3. Results

4.3.1. CAP and AES payments to farmers in Wales

The UK receives a total of £2.8 billion per year from the EU to cover payments made under CAP. Pillar 1 gives around £2.3 billion per year to UK farmers mainly under the Basic Payments Scheme (BPS), provided they carry out certain agricultural activities and comply with standards in areas such as food safety, animal welfare, environmental protection and land maintenance. Pillar 2 gives £0.6 billion of EU funding per year to fund rural development programmes in the UK (NAO, 2017). In 2016, total spending in Wales was £248 million with £190 million allocated to Pillar 1 and £58 million to Pillar 2 (Fig. 4.1).

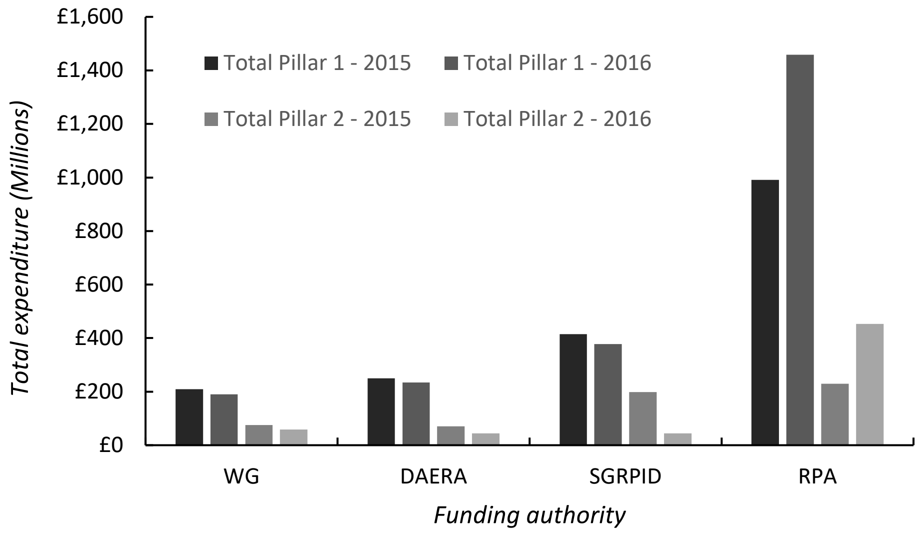


Figure 4.1. Total UK spending on Pillar 1 and Pillar 2 subsidies for the 2015/16 period divided by individual country.[5]

Table 4.1 shows the distribution of Pillar payments by funding category and focus area. Overall, 63% of Pillar 2 funding was spent on AES (2.2% in admin support) and 23% in support of production with the remainder split on administration (3.2%), forestry creation and restoration (8.4%) and support for social enterprises (2.4%). Analysis of AES payments and recipient numbers by postcode areas showed the North-West region (LL postcode) received the largest proportion of AES funding and has the highest levels of participation. The South-West region (SA postcode) had slightly lower levels of participation but funding does not match that of the North-West suggesting participation occurring on a smaller scale (Appendix 1, fig. C1).

[5] Source: WG (Welsh Government), DAERA (Department of Agriculture, Environment and Rural Affairs, Northern Ireland), SGRPID (Scottish Government Rural Payments and Inspections Directorate) and RPA (Rural Payments Agency, England). (DEFRA, 2017).

Table 4.1. Distribution of Pillar 2 subsidies in Wales by funding categories and focus area.

Funding category	Payment (£)	Payments (% of total)	Focus area
Technical assistance	1,849,989	3.2	Administration
Non-productive investments	1,288,860	2.2	Agri-environment (Support)
Agri-environment-climate	27,834,285	47.8	Agri-environment
Agri-environment payments	7,573,423	13.0	Agri-environment
Investments in physical assets	7,657,814	13.0	Production
Organic farming	3,957,679	6.8	Production
Development of new products, processes and technologies	942,128	1.6	Production
Modernisation of agricultural holdings	883,297	1.5	Production
Implementing local development strategies	33,810	0.1	Production
Implementing cooperation projects	47,505	0.1	Production

Investment in forest area development and improvement of forest viability	3,222,356	5.5	Forestry
Adding value to agricultural and forestry products	1,532,227	2.6	Forestry
First afforestation of agricultural land	106,051	0.2	Forestry
First afforestation of non-agricultural land	17,132	0.1	Forestry
Implementing local development strategies. Quality of life/diversification	456,453	0.8	Social
Basic services for the economy and rural population	366,332	0.6	Social
Skills acquisition, animation and implementation of local development strategies	244,731	0.4	Social

Vocational training and information actions	170,782	0.3	Social
Running the local action group, acquiring skills and animating the territory	104,751	0.2	Social
Payments to farmers in areas with handicaps, other than mountain areas	48.87	0.1	Social
Total	58,289,654	100	

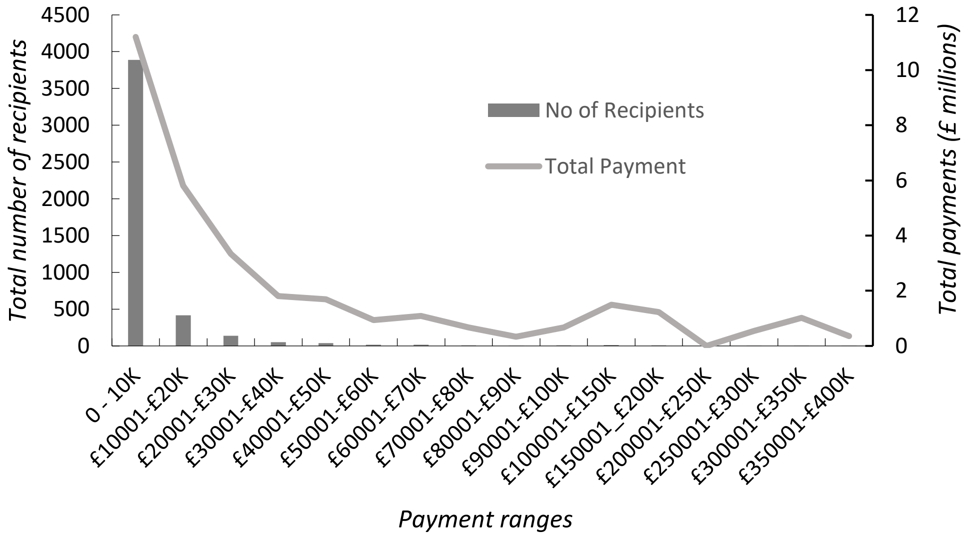


Figure 4.2. Distribution of 2016 agri-environment payments in Wales/UK showing the total number of recipients and the total payments received by payment range. Source: DEFRA (2017).

Uneven distribution patterns are observed between payment ranges (Fig. 4.2). Analysis of farm payment data revealed that 84% of recipients of AES payments were in the £0-10k category, comprising only 35% of the total available funding. Of these, 54% of the recipients received <£4k year-1 (Appendix 1, fig. C2). In contrast, <1% of the total number of recipients received payments exceeding £100k, accounting for 14% of the total available funding.

4.3.2. Distribution of options within the Glastir entry (GE) and Glastir advanced (GA)

Glastir is the latest in a line of AES which has seen land involved in Welsh AES rise from 0.01 million ha in 1992 to 0.25 million ha in 2016 (Banks and Marsden, 2000; JNCC, 2017). Glastir contracts consist of a Whole Farm Code (WFC), which contains general rules affecting all land on the farm, and various management options (Appendix 1, table C1; table C2). In GE level schemes, farmers select options that meet or exceed a point's threshold related to the area of eligible land on the farm entered into the scheme (WG, 2015b). In GA level schemes, applying farms are assessed for their ability to deliver against objectives (WG, 2015c). The maps in Figure 4.3 show the uptake and distribution of management options within land parcels entered into agreements under the Land Parcel Identification System (LPIS; see Appendix A for further details of the LPIS). This enabled the levels of spatial overlap between schemes to be identified, especially at GA and GE levels where, prior to 2015, participation in the lower-level scheme was a prerequisite for entry into the higher. Our study shows the greatest concentration of AES management options occurring in upland unimproved agricultural areas (Agricultural land classes 4 and 5; Fig. 4.4a) predominantly comprising of acid and calcareous grasslands and heather moorland habitats (Fig. 4.4b).

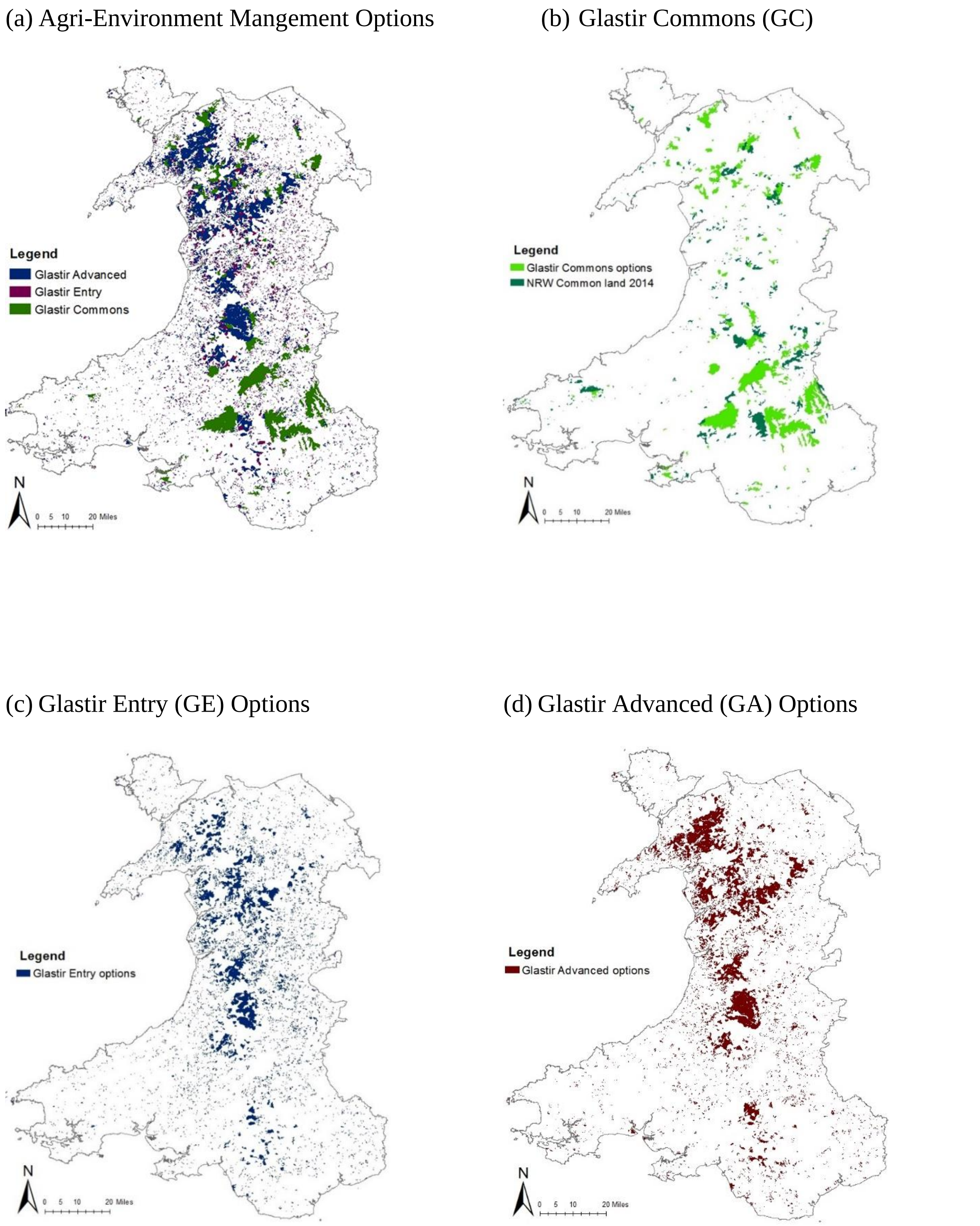


Figure 4.3. Scale and concentration of targeted management options within land parcels entered into the agreement under the land-parcel identification system (LPIS) in Wales. (a) Combined agri-environment schemes, (b) Glastir Commons superimposed onto the NRW (2014) Registered Common Land map (RPA, 2017), (c) Glastir Entry, and (d) Glastir Advanced.[6]

[6] © RPA /NRW/ WG. © Crown copyright / database right 2017. An Ordnance Survey / EDINA supplied service.

4.3.3. *Distribution of Glastir commons (GC) Glastir woodland creation (GWC) and Glastir woodland regeneration (GWR)*

In 2016, GC covered 118,000 ha of common land (JNCC, 2017). This was significantly higher that under the predecessor to Glastir (Tir Gofal, 1999-2011), where agreements covered only 2% of the common land in Wales (WG, 2015d). By superimposing the 2017 GC dataset onto the NRW (2014) Registered Common Land Map, a GC distribution map (Fig. 4.3b) was created to show GC management options covered 65% of common land, principally upland habitats.

"Woodlands for Wales", the Welsh Government's fifty-year strategy for promoting woodland planting and management in Wales, was published in 2001 and revised in 2009 (WG, 2015e). It contained an aspiration to create 100,000 ha of new woodland between 2010 and 2030 as a means to help Wales meet its carbon emission reduction targets (WG, 2010; WG, 2016b). The latest indicators of its success (WG, 2015e), however, showed a slight decrease in the estimated area of woodland cover in Wales from 2001-2010. With a requirement to deliver woodland planting at a rate of 5,000 ha annum^{-1} this target was subsequently assessed to be unachievable and a government-commissioned review in 2014 amended the aspiration to 50,000 ha by 2040 (WG, 2016b). The uptake of GWC options across the country is shown to be very limited, occurring on a small scale and often located on existing acid grasslands (Fig. 4.4b; Fig. 4.4d). GWR options aim to replant areas of larch *Larix decidua* felled to help prevent the spread of *Phytophthora ramorum* disease (WG, 2017c). Fig. 4.4d shows a greater uptake of GWR options than GWC, restoring woodland in areas currently devoid of trees, (Fig. 4.4c). Uptake of GA and GE level woodland options is low and sporadically distributed throughout the country (e.g., GA woodland options made up only 9% of the total option uptake in 2015, dropping to 3% in 2017; Fig. 4.4d).

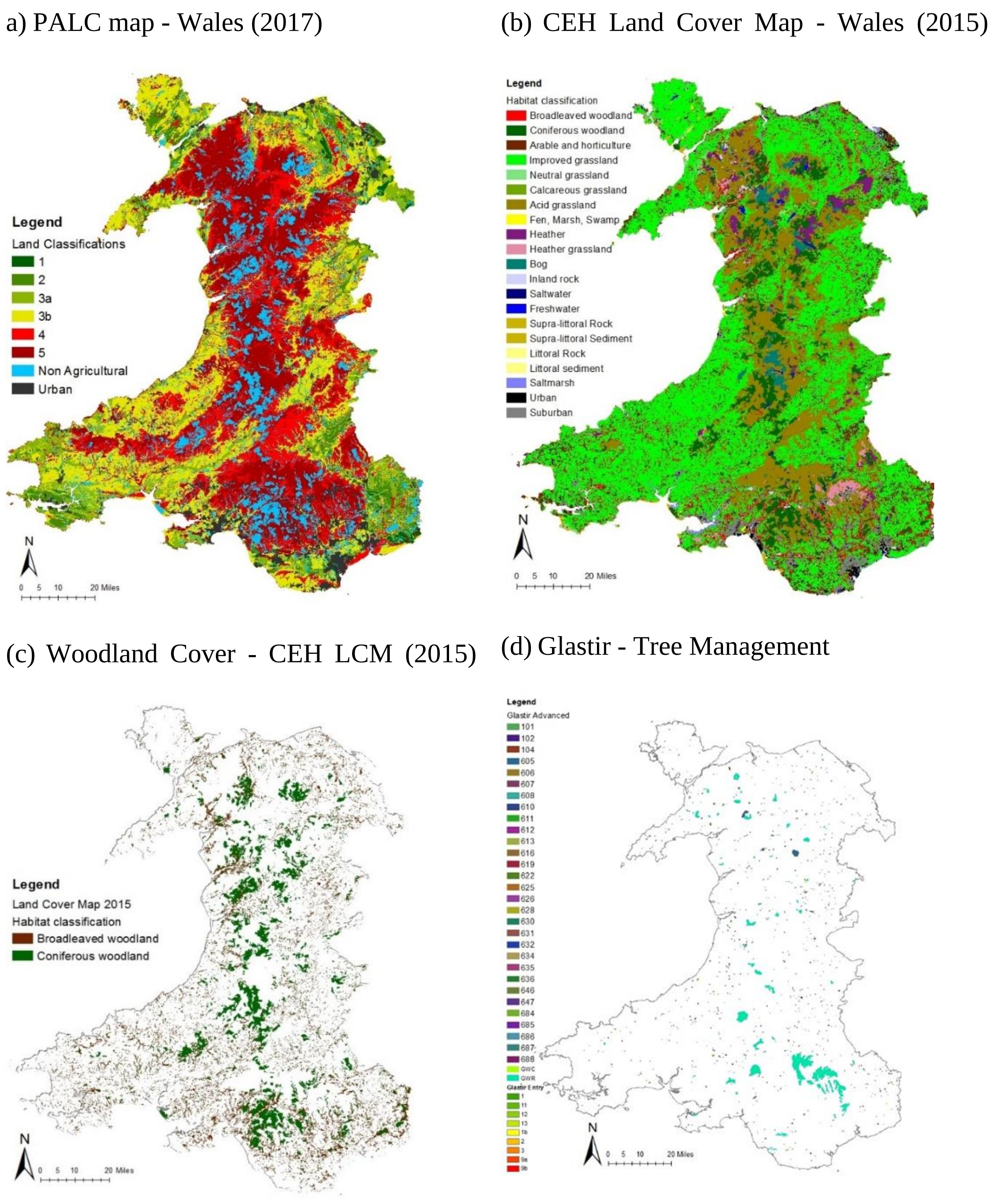


Figure 4.4 (a) Predictive Agriculture Land Classification (PALC) (See Appendix A for land classification descriptions). (b) Land Cover map for Wales. (c) The distribution of woodland

habitats in Wales and (d) The woodland management options delivered through Glastir Advanced, Entry, Woodlands Creation and Woodlands Restoration.[7]

4.3.4. Glastir management options and land management categories

Glastir AES contracts are issued for a five-year period. In 2015, there were 168 targeted GA and 57 GE management options available to farmers. In 2017, the number of managed options had changed, 166 for GA (Appendix 1, table B1) and 61 for GE (Appendix 1, table B2). Of those, 15 management options accounted for >75% of all management contracts awarded in both 2015 and 2017. Further, ca. 40% of all GA and GE management options were targeted towards low or no input grazed pasture or woodland stock exclusion (Table 4.2). In 2017, 78 of the 166 GA options, individually, comprised ≤ 0.1% of the total option uptake. Of these 35 options had <10 contracts awarded per option.

Table 4.2. Top 15 management agri-environment scheme options adopted by farmers in the Glastir Entry (GE) and Glastir Advanced (GA) schemes in 2017. Source: RPA (2017).

Option description	No. of contracts awarded	Options (% of total)
Glastir Entry (GE)		
1. Grazed pasture - no inputs	10759	18.2
2. Grazed pasture - low inputs	10547	17.9
3. Management lowland marshy grassland	5306	9.0
4. Hedgerow management - both sides	3253	5.5

[7] Source: RPA (2017); CEH (2017) and WG (2017e). © Welsh Government © Crown copyright / database right 2017. An Ordnance Survey / EDINA supplied service

5.	Hedgerow management external boundary (1 side only)	3128	5.3
6.	Continued management of existing streamside corridor	2886	4.9
7.	Enhanced hedgerow management - both sides	2180	3.7
8.	Grazed pasture - low inputs and mixed grazing	2105	3.6
9.	Hedgerow restoration without fencing	1931	3.3
10.	Hedgerow restoration with fencing	1681	2.8
11.	Maintenance existing hay-meadow	1634	2.8
12.	Grazing management of open country	1345	2.3
13.	Grazed pasture - no inputs and mixed grazing	1201	2.0
14.	Create streamside corridor on improved land on both sides of a watercourse	1170	2.0
15.	Create streamside corridor on improved land on one side of a watercourse	955	1.6
Total		50081	84.9
Glastir Advanced (GA)			
1.	Grazed pasture - no inputs	11391	20.6
2.	Woodland - stock exclusion	10438	18.9
3.	Lowland marshy grassland	2758	5.0
4.	Management lowland marshy grassland	2657	4.8
5.	Grazed pasture - low inputs	2531	4.6

6.	Additional management payment - reduce stocking	2246	4.1
7.	Grazing management of open country	1671	3.0
8.	Streamside corridor management	1549	2.8
9.	Hard surfacing	1531	2.8
10.	Maintenance existing hay-meadow	1098	2.0
11.	Enhanced hedgerow management - both sides	1095	2.0
12.	Scrub clearance - hand	1028	1.9
13.	Bracken control - mechanical two cuts/year	824	1.5
14.	Lowland unimproved acid grassland	636	1.1
15.	Grassland managed with no inputs between Oct. and Jan	631	1.5
Total		42084	76.6

4.3.5. Habitat management

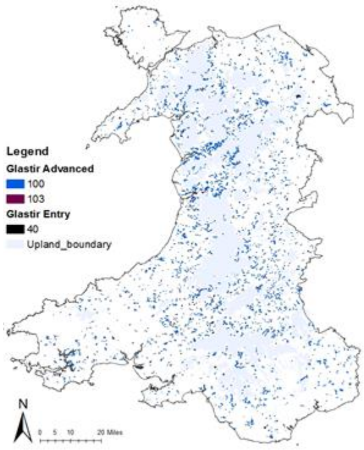
The uptake of habitat management options exceeded all other management categories in both GA and GE across both years (Appendix 1, fig. B1). Overall, 58% of GA options were targeted at habitat management and 19% to stock management while for GE, 44% of the options delivered habitat management in the form of grazed pastures and stock reduction/exclusion (Fig. 4.5). Comparison between the distribution of zero, (Fig. 4.5cd) or low-input (Fig. 4.5e), grazing options and management of open countryside (Fig. 4.5f) with land cover (Fig. 4.4b) found the greatest concentration of these options occur on acid or calcareous grasslands (ALC class 4 and 5) where there is little history of land improvement or nutrient input (i.e., business as usual) regardless of entry in AES. These options will help ensure the maintenance of low or no input situations, preventing increases in nutrient burdens over the 5-year contractual period.

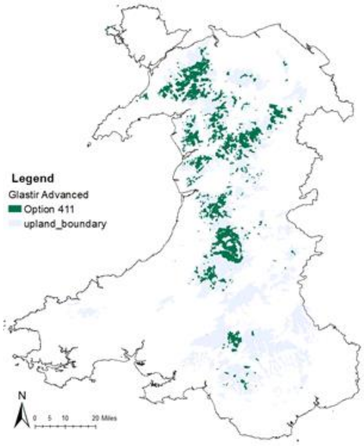
4.3.6. Livestock exclusion/reduction and vegetation management

Comparison between vegetation management options to promote biodiversity (Fig. 4.6b) and stock exclusion (Fig. 4.5a) and stock reduction (Fig. 4.5b) options shows significant overlap (i.e., conflict) within the same land parcels. Analysis of the extent of upland and lowland bracken cover (Fig. 4.6a) was shown to far exceed the levels of bracken control (Fig. 4.6b) provided through GA and GE management options.

a) Glastir - stock exclusion options

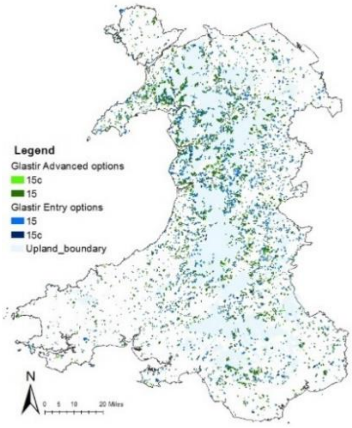
(b) GA - stock reduction option

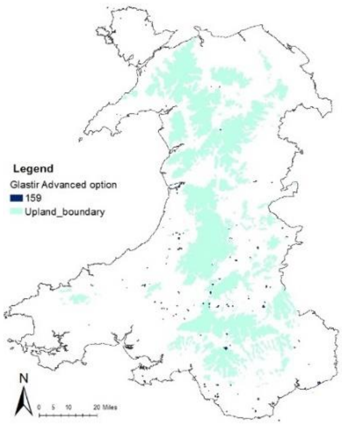




(c) Glastir - grazed pasture no inputs

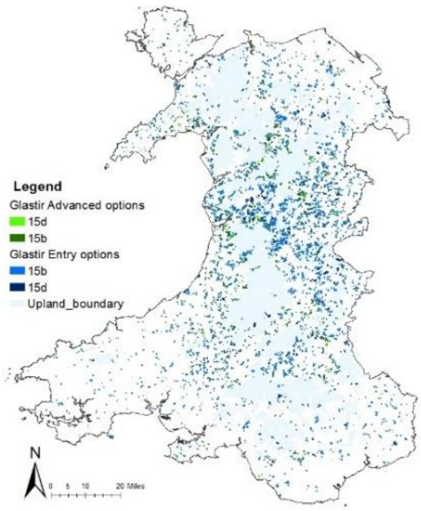
(d) GA - no nutrient input 15 Oct - 31 Jan





(e) Glastir - grazed pasture low inputs

(f) Glastir - management of open country



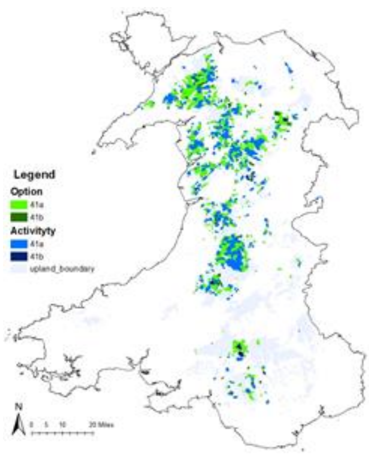


Figure 4.5. Habitat management by grazing and stock exclusion in 2017. (a) Stock exclusion management options for GA/GE. (b) GA stock reduction option. (c) GA/GE grazed pastures with no inputs and with no inputs and mixed grazing. (d): Stock exclusion during certain dates. (e): GA/GE grazed pasture with low inputs and with low inputs and mixed grazing. (f): GA/GE management of open country options.[8]

4.3.7. Habitat management for birds

GA has several management options aimed at habitat management to promote bird populations (Appendix 1, fig. B6). Figure 4.6c shows the relatively low uptake and sparse distribution of these options at the national scale. Using lapwing (*Vanellus vanellus*) management options as an example, distribution patterns are explored to identify the potential effectiveness of current options. Overlaying the GA management options for lapwing onto the current lapwing distribution map (Zolnai, 2017; Fig. 4.6d), showed no habitat management options occurring close to the highest lapwing population areas. Conversely, it showed concentrations of option uptake in areas with no previous history of nesting lapwing populations.

4.3.8. Water related management options

Water related AES options make up only 3% of total option uptake and consist of options mainly targeting riparian zones through streamside corridor management, and the introduction of buffer zones (Appendix 1, figs. B1-2). The majority of streamside management contracts are awarded in the 'broad and shallow' GE element (Fig. 4.7 a). Jones et al. (2017) demonstrate that AES can deliver reductions in diffuse pollution from agriculture, but scheme

[8] Source: RPA (2017). © Crown copyright / database right 2017. An Ordnance Survey / EDINA supplied service.

effectiveness is difficult to determine and effects, where detected, are not evenly distributed across the landscape.

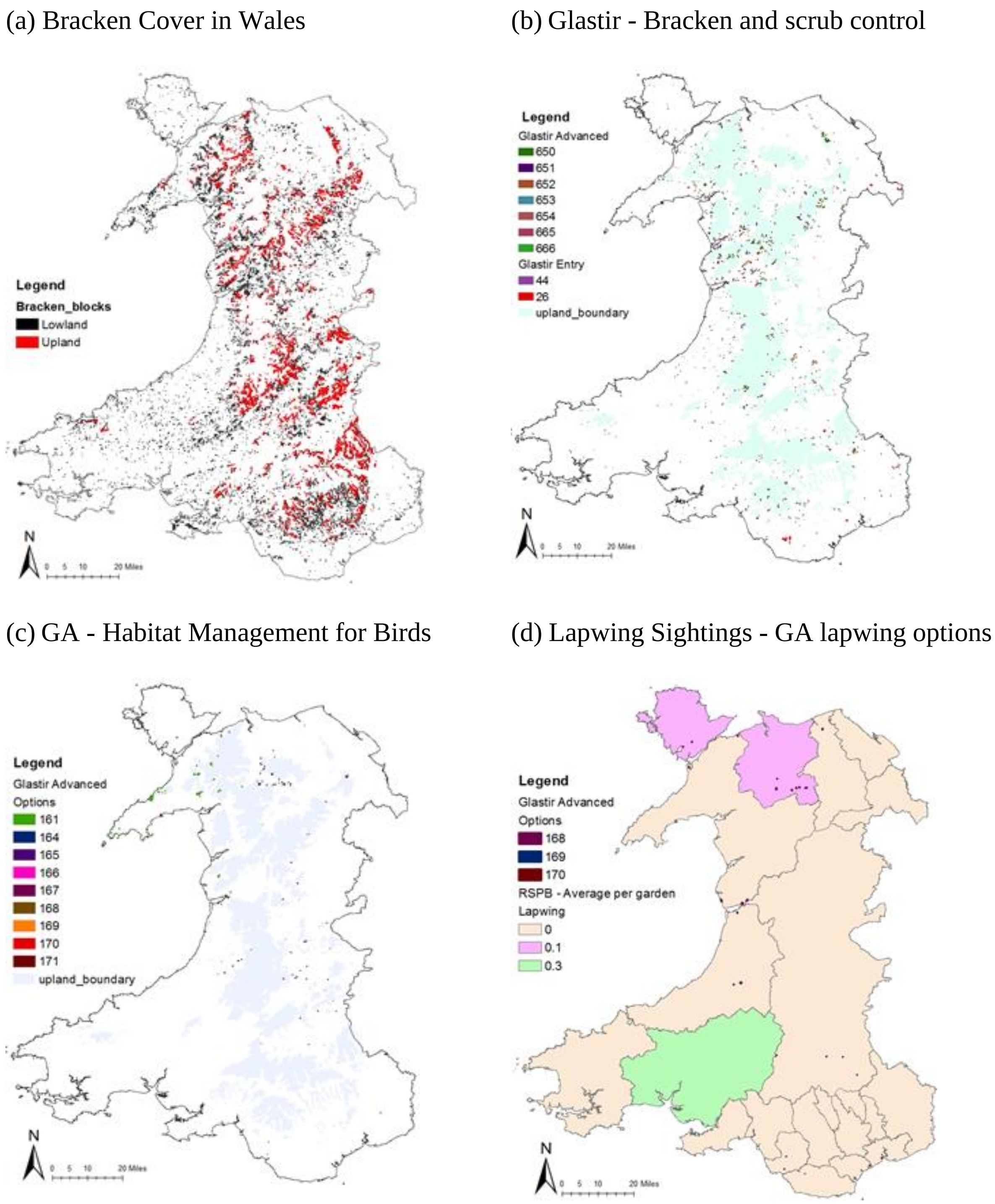


Figure 4.6 Vegetation and bird management categories. (a) Bracken coverage map taken for the NRW Phase 1 terrestrial habitat data. (b) GA and GE bramble, bracken and scrub management options (Aerial, hand, mechanical and tractor delivered). (c) The distribution of

This study supports these findings by showing an uneven distribution of GA management options countrywide, with large gaps in coverage in the South East and South West. A comparison with the Water Watch Map (NRW, 2016), which provides key information relating to the Water Framework Directive (EC, 2000) river water quality classifications, (Fig. 4.7b), shows major gaps in management option distribution coinciding with areas with the poorest water quality.

GA options targeting lapwing habitat and (d) the results from the RSPB Garden Survey (2016) showing the mean sightings of lapwings Vanellus Bards in Wales[9]*.*

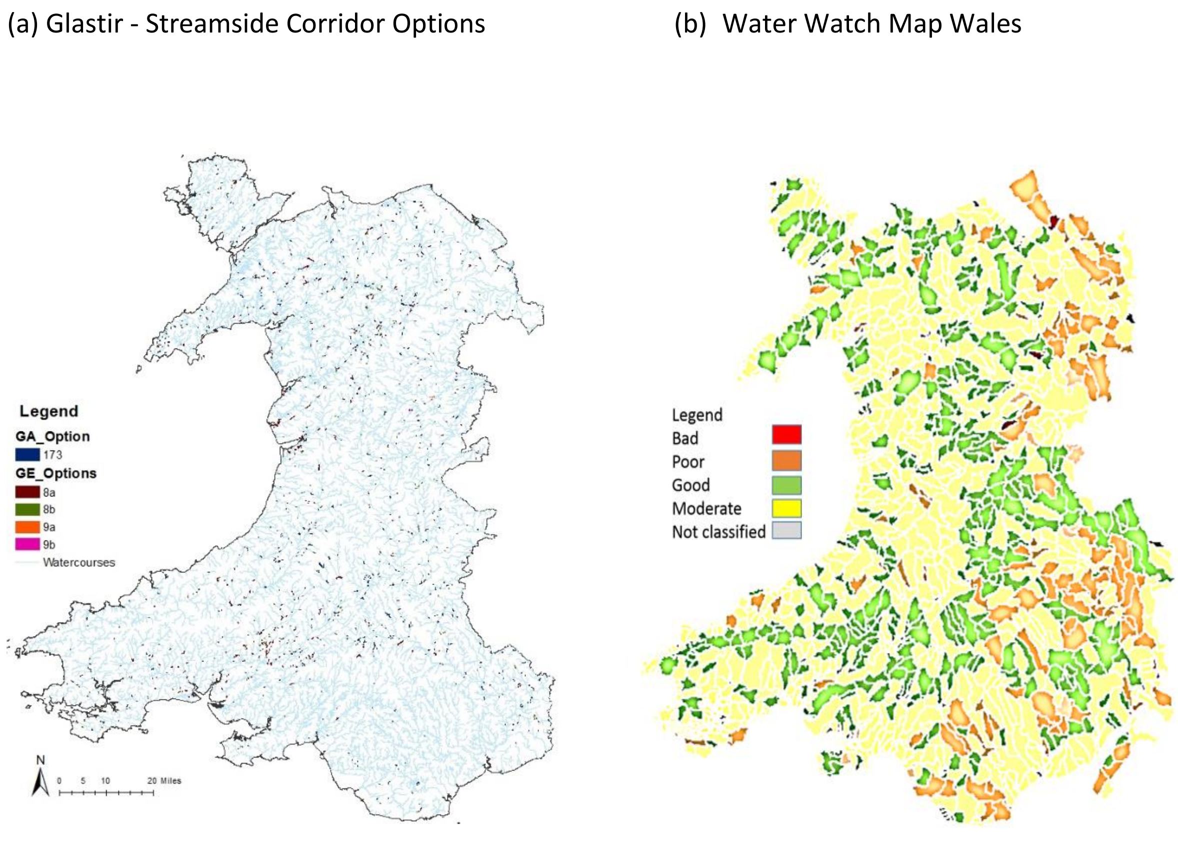


Figure 4.7. (a) Glastir Entry and Glastir Advanced streamside corridor management options overlaid onto the river courses of Wales (OS, Opendata, 2017). (b) The Water Watch Map of

[9] Source: RPA (2017); Zolnai (2017). “Contains Natural Resources Wales information © Natural Resources Wales and database right”. © RSPB © RPA/WG © Crown copyright / database right 2017. An Ordnance Survey / EDINA supplied service. Ordnance Survey license number 100019741.

Wales - Cycle 1 Rivers and waterbodies showing the condition of the river from poor to good with an 'as yet unclassified' category[10].

4.4. Discussion

4.4.1. Policy and payments data

Historically, a primary role of the CAP has been the provision of income support and social security for farmers (Helm, 2017), however, previous studies have found farms receiving greater direct payments were less efficient, on average, than other farms (Kleinhanß et al., 2007; Ferjani, 2008; Latruffe et al., 2017). Focusing on the distribution of AES funding, this study shows higher levels of funding in areas most suited to the delivery of ecosystem services, namely mid and north Wales. On a spatial scale, this distribution pattern is positive, but here it is argued that individual payment distribution patterns show, that like Pillar 1 payments (Helm, 2016), the majority of payments go to bigger and richer landowners with the majority (84%) of recipients receiving only 35% of the total AES budget.

It could also be argued, that to achieve landscape-level impacts, funding should focus on those able to deliver AES on a large scale. This study agrees with this argument but shows that in Wales the majority of recipients of AES payments deliver prescriptions on a field-scale level and therefore argues that the prescriptive nature of the schemes means that the 957 farmers receiving 65% of the funding do not effectively deliver ecosystem services at a landscape-level. Difficulties arise in assessing the full impact of AES as habitat change is slow due to lag times in ecosystem processes (Emmett et al,. 2017), but here it is argued that the effectiveness of AES on a temporal scale will be significantly impaired by the spatial scale of delivery combined with the prescriptive, action-based nature of Pillar 2 funded schemes.

[10] Source: RPA (2017); NRW (2016b).

Future agricultural subsidy support is likely to be linked to the provision of ‘Public Goods’ (Gove, 2017), which are described as goods and services with properties of non-rivalry and non-excludability (Dwyer et al., 2015), which are often under-produced, or not produced at all in the private sector (Holcombe, 1997). This means that, less favoured areas (upland habitats), with their deeply entrenched ecosystem services and goods, are likely to feature significantly in the distribution of future funding. Such habitats are the source of around 70% of the UK’s drinking water, hold an estimated 40% of the UK’s soil carbon, and include some of the country’s most iconic cultural and aesthetic landscapes (UKNEA, 2011). The innovative ecosystem services approach, currently promoted by the Welsh Government as a delivery means, commodifies environmental goods in an attempt to counteract market failures, but it is not without challenges to its implementation (Davies-Jones, 2011; Wynne-Jones, 2013; Potter and Wolf, 2014). If policy-makers, engage farmers in scheme design (Davies-Jones, 2011), provide knowledge and skills that enhance cultural and social capital (Wynne-Jones, 2013) and overcome the methodological challenges of linking payments to outcomes (Potter and Wolf, 2014) they may be able incorporate these commodities into the production chain and hypothetically, create a ‘win-win’ situation, certainly in upland areas.

The first barrier to the success of AES and the delivery of ‘Public Goods’ is that of economics. The CAP, through its ‘greening’ element and Wales, through the Well-being of Future Generations (Wales) Act 2015 (WG, 2015a), uses a multi-functional, environmentally friendly discourse to promote social, economic, environmental and cultural sustainability (Daugbjerg and Swinbank, 2016; Davies, 2016, 2017; EC, 2017). However, this sustainability discourse is not reflected in reality when it comes to funding (Erjavec and Erjavec, 2015). Agricultural subsidies are heavily skewed towards direct support payments. For example, <15% of total agricultural support funding available in Wales is spent on AES with the remainder being spent in support of production and the development of rural communities (Defra, 2017b).

In Wales, the highest levels of AES payments are disbursed in areas rich in upland habitat, low-input farming and low farm incomes. This positive distribution pattern implies a level of targeting by the policymakers and a willingness by farmers, in these areas, to participate in AES. Theoretically, this combination of targeted funding, suitable landscape and a willingness to participate should result in the successful delivery of “Public Goods”. In reality, this combination has failed to effectively deliver results, for example, the UK farmland bird index decreased 9% between 2010 and 2015 (Defra, 2017c) and since 2013, the amount of farm woodland within a grant scheme has begun to decrease (WG, 2015e). In addition, the Auditor General for Wales (2014) found the Welsh Government had missed most of its targets for Glastir due to farmer participation being well below those expected by government. Where AES contracts are in place, their effectiveness is difficult to measure, partly due to a lack of measures to evaluate success (Auditor General for Wales, 2014; Jones et al., 2017). Direct subsidy removal would reduce farm household dependence on on-farm income/subsidies potentially creating externalities, which may be positive or negative. In New Zealand, which had a similar subsidy support system to Wales (Federated Farmers of New Zealand, 2002), sheep and beef farmers suffered severely, while for dairy, horticulture and cropping units the overall impact was generally minimal (Smith and Montgomery, 2004). Farming practices changed, dairy farming intensified and expanded dramatically whilst the sheep and beef sectors declined (Federated Farmers of New Zealand, 2002; Smith and Montgomery, 2004; Foote et al., 2015). Levels of intensification required to deliver production increases, which match subsidy loss, is likely to simultaneously increase negative environmental externalities (Foote et al., 2015). In contrast, sudden changes to the farmer’s economic situation has the potential to directly impact on farm viability and increase the risk of land abandonment (Terres et al., 2015). Whilst abandonment may increase carbon sequestration (Munroe et al., 2013) and restore habitats (Keenleyside and Tucker, 2010), it also has the potential to reduce farmland biodiversity (Renwick et al., 2013), create fire risks (Moravec and Zemeckis, 2007) and impact on the cultural landscape (Navarro and Pereira, 2015). However, a shift in policy from a direct payment support system to a 'Public Money for Public Goods' approach (Gove, 2018) is likely to see upland farms in the less productive agricultural areas, more favourable to 'Public Goods' delivery, become the main beneficiaries (Helm, 2017) and that may provide more opportunities for more farmers to enter AES (Lastra-Bravo et al., 2015). Financial investment which enhances farmer participation post-Brexit will help to deliver the "more" approach of Lawton et al. (2010), but significant improvements in the effectiveness of AES through the "bigger, better and joined" approach can only come through commitment to change. Governments must consider scheme design and clearly define the objectives, impact and spatial scale over which they expect schemes to deliver (Auditor General for Wales, 2014).

4.4.2. The spatial scale of scheme delivery and financial support

The spatial scale at which an AES becomes effective is still uncertain; some studies have shown an effect at local scales (Fuentes-Montemayor et al., 2011b; Wilkinson et al., 2012), whilst others cite the main reason for AES failure being a focus at farm scale rather than the landscape scale (Whittingham, 2007; Mckenzie et al., 2013). Tscharntke et al. (2005) argue that subsidies and agri-environment incentives predominantly fund farm-scale AES operations (e.g. reduced input of agrochemicals) and this is supported by this analysis of Welsh payments that found the majority of farmers receiving total annual payments in the £0-10k category. A recent review of the 'broad and shallow' GE scheme concluded that greater environmental benefits and better value for money could be delivered by adopting a more targeted and capital-based approach to agri-environment support (WG, 2017f). This study shows some levels of connectivity between options in upland (ALC 4 and 5) landscapes but the distribution of management options across the remainder of the country appears fragmented and disconnected. With farmland constituting the single largest habitat in the UK (World Bank, 2014), the need to understand the impact of agricultural intensification, and the associated habitat fragmentation, on biodiversity (Fahrig, 2003) and the environment (Tilman, 1999) is vital if AES are to deliver successful outcomes (Tscharntke et al., 2005). The principal risk arising from investment in individual farm scale operations, without attentions to habitat matrix restoration, is that of continued isolation and fragmentation (Donald and Evans, 2006).

4.4.3. Glastir options distribution and uptake

The Natura (2000) management categories are designed to enable Wales to make significant progress towards bringing Natura 2000 species and habitats into favourable condition and help meet its commitments under the European Habitats and Birds Directives (NRW, 2015). The results of this study indicate that option distribution patterns are disproportionately biased towards habitat (excluding wildlife and bird habitat management) and stock management categories. These represent options that can be easily implemented by farmers, or which require little or no change in land management (i.e., payment with no environmental benefit). It is therefore not surprising that this bias reduces the ability of Glastir to deliver landscape level environmental outcomes for Tree, Infrastructure and Access, Water and Drainage, Wildlife, Agri-management, and Bird management categories.

4.4.4. Habitat management

The management options associated with habitat management are largely located on upland farms, with lower agricultural capacity, where farmers often adopt AES as additional sources of income to offset the risks associated with agricultural production on low productivity land (Wilson and Hart, 2000; Lastra-Bravo et al., 2015). The most concentrated areas of habitat management occur on acidic and calcareous grasslands where little or no agricultural improvement has occurred, supporting the theory that due to lower agricultural opportunity costs, peripheral, marginal and difficult-to-farm areas are particularly likely to be enrolled in AES (Evans and Morris, 1997). Farmers often select, or apply to participate in, scheme prescriptions that fit the farm situation with low costs of compliance or minimum changes to current management practice (Morris and Potter, 1995; Morris et al., 2000). This bias in option uptake has been identified as a primary reason why AES may fail to deliver biodiversity benefits (Evans and Morris, 1997; Davey et al., 2010). However, the five-year contractual period binding farmers to management option delivery and the whole farm element of AES does, at the simplest level, ensure the maintenance of existing habitats on farmland and, through favourable management practices, help prevent further agricultural intensification and habitat loss (Ovenden et al., 1998).

4.4.5. Livestock and vegetation management

Glastir has two main approaches to stock management - reduction and exclusion. These approaches are arguably easier options to monitor than habitat management but they frequently fail to deliver the desired effect of habitat protection (Joyce, 2012; Plantlife, 2012; Mansfield, 2015). In most woodland types, species and structural diversity are higher when some browsing and grazing occurs (Hodge and Pepper, 1998). Consequently, the introduction of exclusion zones often negatively affects structural complexity and habitat diversity due to a rise in domination by weed species (Plantlife, 2012). The Welsh Government (2015b), in a self-assessment, highlighted the fact that there was no option for light grazing and that the widespread use of stock exclusion risked replacing one kind of uniformity with another. In some cases the payment for reduced stocking was being made even though heterogeneity, in the form of shorter more heavily grazed areas, would have benefitted endangered bird species such as curlew, chough and ring ouzel, leading to the need for multiple management options on the same parcel of land (WG, 2015d). This study supports these findings by showing additional vegetation management requirements, (scrub and bracken control), occurring on the same land parcel as exclusion options. This infers a failure to achieve the desired effect through poor scheme design.

GA environmental goals include GHG emission reduction, Carbon storage increases and the reversal in the decline of Wales' native biodiversity (Appendix A). Enteric fermentation (CH_4 emissions) constitutes the largest component of on-farm emissions from livestock production (e.g., ~58%, Taylor et al., 2010). The simplest approach to mitigating GHG emissions in grazed pasture systems is to reduce livestock numbers (Luo et al., 2010). Since 2012, however, sheep numbers in Wales have risen by ca. 1 million, dairy cattle have risen to 2004 levels and whilst beef cattle numbers reduced 2004 - 2016, they have since stabilised and started to increase once more. Beef cattle decreases are most likely attributed to market forces and changes to the CAP single payment scheme (Neil, 2017). Joyce (2012) found a reduction in sheep numbers in the Cambrian Mountains but a 9-fold increase in nearby lowland areas so, whilst stock reduction options have had reduced numbers on the hill, they have had no effect on overall livestock numbers and consequently are expected to have little impact on net agricultural GHG emissions. The introduction of AES has been a major driver of change in traditional farming practices in the uplands. A succession of agri-environment schemes has provided an economic lifeline for many farmers, but they have also changed grazing regimes and traditional upland farming practices (Joyce, 2012; Hughes, 2017). Prescriptions require reduced stocking rates on the hill, and this has led to a reduction in sheep numbers in the hills by up to 50% (Hughes, 2017). The availability of new capital, through involvement in AES, has meant that some farmers were motivated to acquire additional land in the lowlands in order to maintain the size of their sheep enterprise. This has often involved the development of lowland cross-breeding flocks which explains the shift in sheep number distribution across the grazing livestock sector (Hughes, 2017).

The findings of this study show vegetation management options co-occurring on the same land parcels as reduction and exclusion options. The removal of grazing can lead to an increase in scrub (Pollock et al., 2013), bracken (*Pteridium aquilinum*, Pakeman et al., 2000; Marrs et al., 2007) and Molinia (*Molinia varia*, Joyce, 2012). These increases represent a major invasive weed problem in agricultural grasslands (Alday et al., 2013) and are generally perceived to be bad for biodiversity (Marrs et al., 2000), with a few exceptions (Woodhouse et al., 2005). Management of these weed problems often requires intervention in the form of a vegetation control option (Ovenden et al., 1998). In the case of stock reduction and exclusion, a lack of impact assessment and defined outcomes has resulted in a failure to achieve the desired increase in biodiversity and an unnecessary doubling of payments on single land parcels.

4.4.6. Management for trees

A primary delivery mechanism to achieve strategic woodland objectives is through the GWC and GWR schemes, although both GE and GA have basic woodland management options. Participation in woodland contracts in the farming community is shown to be minimal and this is likely due to changes in land management practices e.g. in the past, the planting of native woodland was an integral part of most farms, but with policy change, the intensification of agriculture and the large scale planting of conifers, woodlands began to be seen as an alternative to agriculture rather than being an integral part of it, and a lack of communication and engagement between government and the farming community (Osmond and Upton, 2012.; Wynne-Jones, 2013). Where uptake has occurred, a lack of impact assessment has led to cases (e.g. in the Monmouthshire and Denbighshire regions) where Glastir woodland has been inappropriately planted on species-rich semi-natural grassland (Plantlife, 2012). On a positive note, GWR is shown to be having some effect at woodland restoration but a lack of connectivity to other woodland blocks potentially contributes to, rather than reduces, the island effect (MacArthur, and Wilson, 2001). Recent estimates, which suggest an increase in woodland cover since 2010, have been attributed to improved measurement techniques rather than physical increases in woodland coverage due to the success of delivery mechanisms (WG, 2016c).

4.4.7. Management for birds

The Royal Society for the Protection of Birds (RSPB), the UK's largest nature conservation charity, is actively involved in monitoring the effectiveness of AES in recovering farmland biodiversity across the UK (RSPB, 2017). Farmland bird populations, declining on a global scale, are widely used by policymakers as indicators of the wider state of nature. In the US, populations of 57 of 77 (74%) farmland-associated species decreased from 1966 to 2013 (Stanton et al., 2018); in Europe, farmland birds have fared particularly badly, with 300 million fewer birds today than in 1980 (Magalhães, et al., 2013); whilst in the UK, they are generally believed to have declined by 48% since 1970 (Robinson, et al., 2016). There is evidence that both agri-environment prescriptions and targeted conservation management, through recovery projects, can provide positive benefits to breeding Lapwing, stemming or even reversing recent population declines (Sheldon et al., 2004). However, to be successful, AES measures at field, or farm level, must be targeted and embedded within landscape level habitats managed for suitable invertebrate food sources within easy reach (Stevens and Bradbury, 2006; Dallimer et al., 2010; McHugh et al., 2017). Management options are designed to promote bird population recovery but they are largely fragmented and confined to farm or field scale. With the exception of a small concentration of options in North Wales, the low uptake and fragmented levels of lapwing AES interventions, used as an example in this study, may limit usefulness as a tool for population recovery (Smart et al., 2013). The RSPB 2013 Birdcount (Zolnai, 2017) and the Breeding Bird Survey 2016 (Robinson, et al., 2016) report a continued decline in various bird populations targeted by AES suggesting a lack of impact.

4.4.8. Water related management

Riparian zones are most commonly referred to as vegetated buffer strips (e.g., riparian buffer strips) or as wildlife movement corridors (e.g. riparian corridors; Fischer and Fischenich, 2000). Managed correctly, they can be effective in targeting a range of multiple objectives for water quality, stability, and habitat functions (Fischer and Fischenich, 2000) but recommended widths vary greatly according to the desired management outcomes (Wenger, 1999; Hawes and Smith, 2005; de Sosa et al., 2018). Simply fencing off riparian zones, may have limited effects on the conservation of farmland biodiversity (Madden et al., 2015) and, especially in the early formation stages, lead to the growth of invasive species such as Japanese Knotweed (Moore, 2018). Glastir management options stipulate that streamside corridors must be fenced off from stock, for the duration of the contract, at a minimum of 3.5 m from the watercourse. Narrow corridors such as these have proven effective in the short term, although long-term studies suggest the need for much wider buffers (Fischer and Fischenich, 2000; Poole et al., 2013; de Sosa et al., 2018). Once again the question of desired outcome arises. Fischer and Fischenich (2000) give recommended widths of corridors and buffer strips for vegetation, reptiles and amphibians, mammals, fish, invertebrates, birds and water quality. With the exception of one general recommendation for Detrital Input, there are no recommendations for widths less than 4 m, raising questions on the effectiveness of a 3.5 m buffer strip. In Wales, there is an even distribution of AES streamside corridor management across the country, but there are still large areas of poor water quality where options are needed but have not been adopted by farmers (e.g. SW and SE Wales) (NRW, 2016). It is argued that the narrow width of Glastir streamside corridors, combined with the voluntary nature of the scheme, limit the effectiveness of prescriptive AES as a water quality, management tool. It could be argued that the controlled grazing regimes of GC, and other stock reduction options, contribute to water quality management in the upland headwater areas but in the South-East where there are reasonably high levels of GC participation water quality is amongst the poorest in the country.

4.4.9. *Management for biodiversity*

AES options, across all management categories, are aimed at maintaining and enhancing biodiversity (Appendix A). Current evidence differs on the effectiveness of action-based habitat options for promoting biodiversity. Interventions have been shown by some to be effective; small mammal communities on arable farmland (Broughton et al., 2014); honey bees on rural land managed under UK Higher Level AESs (Couvillon et al., 2014); hay meadows for biodiversity (Knop et al., 2006) and pollinator species richness and abundance (Albrecht et al., 2007). However, many studies have found current AES to be ineffective - no increase in herpetofaunal diversity in the short term (Michael et al., 2014); no improvement of plant biodiversity in ditch banks after a decade of agri-environment schemes (Blomqvist et al., 2009). Further, Kleijn et al. (2001) found management agreements had no positive effects on plant and bird species diversity. On balance, the evidence presented here, and elsewhere, suggests that better targeting of AES would deliver impacts that are more effective.

4.4.10. *Human, social and cultural capital*

This study, has discussed the complexities of option uptake and deliver through Glastir, the Welsh government's action-based AES but one of the greatest barriers to the success of any scheme has to be a non-willingness to participate within the farming community and a lack of behavioural change. Voluntary AESs are voluntary in that participation, management options and area entered are optional (Burton et al., 2008). Methods of delivery are not voluntary, 'they do not promote any voluntary actions for environmental protection; they just force farmers to follow the standard rule' (Kaljonen, 2006). 5-year contracts require no deep personal involvement or changes in farm management strategies (de Snoo et al., 2013) and often, as a result of their prescriptive nature, do not even require farmers to learn anything about "good" conservation practice (Burton et al., 2008). The development of social and cultural capital is a key factor in the development of schemes which promote long-term behavioural change and foster a willingness to participate (de Krom, 2017; Burton and Paragahawewa, 2011). Result-oriented agri-environmental schemes are seen by some as a means to encourage farmer innovation in the production of environmental goods (Burton and Schwarz, 2013a) and improve AES efficiency (Sabatier et al., 2012; Schroeder et al., 2013). It is also worth considering at this point reasons for non-participation. Wilson and Hart (2000) found 49% (n=211) of interviewed farmers did not participate in AES as it `did not fit in with their farm management plans' but, non-participation may not necessarily be through choice. Entry into a scheme may be hindered due to a lack of eligibility, through farm size or land/habitat type (Wilson, 1997; WG, 2015c).

4.5. Conclusions and recommendations

AES, currently embedded in EU and Welsh policies, promote '*greening*', '*sustainability*' and '*ecosystem services'* approaches to land management. The funding structures of these policies, however, run counter to this sustainable approach, and create the first barrier to AES success, through a continued focus on productivity support. In this study, we have shown funding, scheme distribution and higher participation levels principally located on upland farms, in the less favoured areas, more favourable to 'Public Goods' delivery. Non-eligibility, a barrier to participation and therefore funding and scheme distribution, is more likely to affect lowland farmers, especially those wishing to gain access to higher-level schemes (GA), whose land may not be able to deliver the environmental benefits to levels attainable from upland habitats. This lack of eligibility may become significant in post-Brexit scheme design. Gove (2018), proposes the creation of a scheme "accessible to almost any landowner or manager who wishes to enhance the natural environment". It can be argued that "almost any landowner" would depend on where you farm. Upland areas, may see an increase in AES participation, an increase in scale and an increase in willingness to collaborate with others but it is unlikely that farmers willing to participate, but currently ineligible for higher scheme participation in lowland areas, will have access to similar levels of funding. Whilst the possibility of 'land sparing' is not discussed in this study, there is recognition that a change to policy may see the need to support 'sustainable intensification' in areas better suited to production whilst simultaneously taking land out of production in areas better suited to delivering ecosystem services (Bateman and Balmford, 2018).

A post-Brexit policy shift, could lead to an increase in the number of contiguous areas and the linking of habitats in those areas currently fragmented, but the "better and more joined" approach suggested by Lawton, et al. (2010) can only be addressed through co-ordination, and hence government intervention. Glastir has a set of overarching objectives (Appendix A) which it aims to deliver through management options, but this study argues that scheme design hinders progress toward achieving these objectives. Literature clearly identifies causal relationships between prescriptions but, at a governmental level, overarching impact assessments or measurable outcomes for management options appear to be lacking. This leads to the misplacement of options, a duplication of funding within land parcels, and payments for '*business as usual*' options that requires minimum change to farming practice. Whilst this approach maintains a status quo, and stops further intensification and nutrient overload, it is unlikely, through current scheme design, to significantly improve biodiversity (Davey et al., 2010), at a landscape level, or promote long-term behavioural change (de Krom, 2017). Significant improvement in the delivery of "Public Goods" requires spatial coordination of environmental management across multiple farm holdings and collaboration among governmental and other actors, including, possibly, groups of farmers (Westerink et al., 2017), clear objectives for each habitat type and impact assessments which identify the full impact of management options. Policy-makers must think beyond the economic aspects of AES participation (Riley et al., 2018) and invest in structures which embrace the importance of social and cultural capital, promoting peer to peer exchanges and social learning which in turn will raise the professionalism of farmer groups (Westerink et al., 2017). GC is an example of targeted scheme management requiring the formation of collaborative grazing associations to manage common land (Reed et al., 2014). Assessed to be a relatively successful part of the scheme, its good progress was attributed to the provision of Commons Development Officers (CDO) who acted as an independent interface between the farmer group and the government (Brackenbury et al., 2012; Auditor General for Wales, 2014; FCL, 2015). An understanding of needs and good communications skills enabled farmer groups to develop (FCL, 2015) whilst safeguarding the social capital within the group (Riley et al., 2018). The formation of clear objectives and outcomes potentially creates pathways to result-oriented, agri-environment schemes which are on the increase across Europe. The Burren Programme in Ireland (Burren Life Programme, 2015); the Flowering Meadows programme in France (de Sainte Marie, 2014); and the Dartmoor Farming Futures Project (Manning, 2017) are examples of schemes where participating parties receive training to be able to understand the aim of outcomes, what the outcomes should look like and what is meant by good condition. These results-based payment systems allow farmers greater freedom to decide how to manage their land (with advice, if needed) and theoretically provide the taxpayer better value for money (Burton and Schwarz, 2013b; de Sainte Marie, 2014; Burren Life Programme, 2015). Despite the potential environmental, economic and social benefits of result-oriented schemes they are not without risk to the supplier, namely the farmer (Burton and Schwarz, 2013b). Outcomes are often out-with the control of the farmer. Factors such as climate change (Westerink et al., 2008), the behaviour of neighbouring farmers (Aviron et al., 2011) and the breeding, feeding, and migration patterns of mobile species (Westerink et al., 2008) all have the potential to influence willingness to participate. Potential increased transaction costs and difficulties in creating biodiversity metrics and vegetation standards means there may be situations where result-oriented schemes are simply not effective in meeting the provision-goals (Burton and Schwarz, 2013a)

In conclusion, this study shows that current AES funding and scheme structures, whilst in many cases positively prevent further deterioration of existing habitat condition through a ‘business as usual’ approach, the voluntary, prescriptive nature of the schemes limit option uptake, the effectiveness of the scheme as a deliverer of ecosystem services, and the ability to promote long-term behavioural change. It can be argued that current AES are more effective at delivering income support to ensure the viability of predominantly upland farming lifestyles than ecosystem services. This may of course be a government objective but if AES are to deliver “Public Goods”, which meet policy demands, then targeted and adequate levels of funding, suitable landscape and a willingness to participate must be combined with greater farmer autonomy and clear outcomes to deliver management options at a landscape scale.

Acknowledgements

The authors would like to recognise the support of Gary Kingsbury of the Rural Payments Agency, Wales for his support in accessing the Glastir spatial datasets. The FLEXIS (Flexible Integrated Energy Systems) programme funded through the Welsh European Funding Office (WEFO) supported this work.

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Chapter 5

Overcoming barriers to CSS uptake through the decentralisation of agri-environment policy

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This manuscript is currently under review

D.A. designed and conceived the research. D.A. conducted the analysis of the data and prepared the manuscript. All authors discussed results and contributed to preparation of the manuscript.

2.1. Introduction

AES provide centralised financial support to landowners to enable them to implement agri-environment measures aimed at promoting environmental sustainability. Typically, these measures are designed to protect and enhance biodiversity, soil, water, landscape, or air quality, or aid in climate change mitigation or adaptation. Many of these measures are also designed to be multi-functional bringing simultaneous benefits covering several environmental objectives (Ekroos et al., 2014). In most European countries, AES represent the most significant environmental policy delivery mechanism in terms of both expenditure and scale of coverage of the countryside. However, their effectiveness remains controversial due to the inappropriate design of measures and poor uptake and low geographical coverage (Reed et al., 2014; Batáry et al., 2015; Lastro-Bravo et al., 2015).

In England, the Environmental Stewardship Scheme (ESS) is currently in the process of being phased out (ends 31st December 2023; Defra, 2019a) and is being replaced by the CSS which had its first contracts awarded in 2016 (Defra, 2015). However, the transition from ESS to CSS has seen a dramatic drop in AES uptake within the farming community. In 2014, the total number of AES agreements in England (ESS, entry and higher level) was 61,500 covering ~7.7 million ha of agricultural land. However, by 2018, the number of agreements in England (ESS, entry and higher level and CSS) had reduced to 32,500 and the land managed under schemes had reduced to ~3.8 million ha (Defra, 2019b). Post 2023, CSS will be the only mainstream AES available to English farmers until 2027, where a UK departure from the European Union (EU) will see the phasing out of current schemes and the introduction of an ELMS that will replace current AES and the BPS (Defra, 2018). As ESS will end before ELMS is due to be fully functional, participants with contracts ending between 2019 and 2023 will need to apply to join a CSS, wait until the ELMS is operational or consider alternative land management options as a means to replace income lost through previous AES participation. As indicated above, many farmers are not making the transition from ESS to CSS creating a gap in AES coverage across England. This research aims to identify what barriers, perceived or actual, exist to prevent farmers transitioning from ESS to CSS. This information will enhance understanding of farmer intentions to join CSS when ESS contracts expire, facilitating government intervention to encourage greater adoption. It also aims to add insight into how barriers to AES uptake may be overcome through the decentralisation of national schemes.

2.2. Literature review

Due to the voluntary nature of current AES, an understanding of farmer's participation decisions is crucial to ensure the successful delivery of public/environmental goods (Cullen et al., 2017). A qualitative meta-analysis of papers published in peer-reviewed journals between 2000 and 2013 (Lastra-Bravo et al., 2015) identified a number of key drivers for participation in AES including fair payments, lower household dependency on agricultural incomes, age and education levels, the presence of a successor and farms located in areas with lower agricultural production capacity. Farmer characteristics and perceptions also shape opinions towards AES, the environment and farming. Therefore, an understanding of farmer typology will help increase understanding surrounding a farmer's willingness to adopt AES (Cullen et al., 2017; Hyland, et al., 2016). Farmers with 'productivist' attitudes make management decisions based on production and have a lower sense of environmental responsibility than farmers who identify themselves as 'environmentalists' or 'countryside stewards' (Hyland et al., 2016). However, the concept of the farmer as a countryside steward is itself very complex with farmers having differing opinions on the meaning of stewardship. A study of farmers' understanding of stewardship, their landscape values, and land management actions revealed very different views (Raymond et al., 2016). Some view stewardship as maintaining the land in good productive order, some view it as looking after the land in an environmental way, whilst others consider participation in formal government AES as being stewardship. Those who have a more holistic view of stewardship (from both production and conservation perspectives) were identified as having the greatest diversity of landscape values and land management actions on their property (Raymond et al., 2016). Farmers with productivist attitudes often farm more intensive systems, such as dairy and arable, finding the implementation of AES more difficult and costly to implement due to high transaction and opportunity costs whereas, those with a more conservation-based outlook farm smaller, less intensive, farms (Cullen et al., 2017). Location can also be a major contributory factor in a willingness to adopt AES (Lastra-Bravo et al., 2015). Arnott et al. (2019) show AES funding, scheme distribution and higher participation levels principally located on upland farms, in the less favoured areas (LFA), more favourable to 'Public Goods' delivery. However, farmers joining AES in these areas are often more aligned to the economic-oriented farmer (Gallagher, 2018) than the 'environmentalists' or 'countryside stewards' (Hyland et al., 2016), joining AES out of necessity rather than choice. Farmers, especially LFA grazing livestock farmers, will often join AES to mitigate against fluctuations in the market which in turn alter the economic landscape of the farm (Gallagher, 2018), ensuring farm continuity and viability for potential successors (Lastra-Bravo et al, 2015).

However, monetary incentives alone may not be enough to entice or retain farmers into AES. Other forms of non-economic capital, specifically cultural and social capital, also play a role. Farming households and communities with strong bonding social capital i.e., with social ties based on similarity in identity and group belonging (Putnam, 2001), can nudge the decision-making process towards acceptance of AES. Schroeder et al. (2015) found social pressure on farmers' decisions to join AES being more positive when applied by family members, than from the opinions of other farmers or farm advisors. In contrast, Cullen et al. (2017) found the services of an agricultural consultant and the proximity of other participating farmers to be positively associated with participation in AES. Bridging social capital, described as the social ties and extra-community networks that exist across the socio-cultural divisions of different social fields such as between farmers and others e.g., country dwellers, consumers, nature conservationists and governmental agents (Woolcock and Narayan, 2000), can substantively increase AES participation and long-term, pro-environmental behaviour change in farmers. However, this will only occur if farmers succeed in building up bridging social capital through the receipt of appreciation for their agri-environmental work from other stakeholders (de Krom, 2017). Contemporary AES, through their prescriptive nature, may restrict the generation of cultural capital (resources in the form of knowledge, skills, dispositions, and possession of culturally significant objects; Bourdieu, 1986), limiting the likelihood that the behaviours they promote will become culturally embedded within farming communities (de Krom, 2017). If future AES policy-makers are to develop schemes that deliver long term, landscape level environmental results they must assist farmers in building both bridging and cultural capital.

A lack of knowledge can also create unsubstantiated perceptions of barriers to uptake, for example, arable farmers can demonstrate a generic type of resistance to AES based on perceptions that schemes do not suit the overall commercial purpose of their businesses without checking eligibility (Morris et al., 2000). Previous studies show AES uptake being impeded by a lack of farmer awareness and an unavailability of adequate information combined with the fact that current AES are often seen to promote fragmentation, rather than collaboration between farmers (Page and Bellotti, 2015; Leventon et al., 2017). Given the current political situation within the UK and a lack of clarity surrounding the future of AES and other support payments, there is a risk that, on cessation of ESS contracts, farmer uptake of CSS may continue to reduce. There is currently little or no literature to inform scheme providers and stakeholders on the willingness of farmers to participate in CSS during the ELMS transition period. This study aims to close that knowledge gap and further contribute to the literature surrounding barriers to AES uptake.

2.3. Methodology

Because the willingness to participate, or not, in AES is complex, a deep understanding of people's perceptions, attitudes and behaviour is needed. Quantitative studies have the advantage of measuring the reactions of many subjects to a limited set of questions allowing the comparison and statistical aggregation of the data. However, qualitative studies allow the researcher to reveal and understand the complex processes behind the decision-making process (Shah and Corley, 2006) and provide a means for developing an understanding of complex phenomena from the perspectives of those who make the decisions (Denzin and Lincoln, 2011).

5.3.1. Sample design and participant selection procedures

This study comprised in-depth interviews conducted with farmers, across four AES behavioural categories and four farm types (arable, dairy, LFA grazing livestock and lowland grazing livestock), all within the North York Moors National Park Authority (NYMNPA) boundary (Fig. 5.1). Researchers contacted farmers, who had previously indicated a willingness to engage with the NYMNPA, by email and phone. They explained the objectives of the study and asked if the farmer would be willing to participate in face-to-face interviews.

Figure 5.1. The North York Moors National Park boundary. (Source: North York Moors National Park Authority).

Of the 76 approached, 42 farmers agreed to participate in the study, varying in age and gender demographics across four main farm types and behavioural groups. Farm and farmer demographics including farm type, farm size, gender, and age were recorded and based on current involvement in AES, four behavioural groups were defined a priori (Table 5.1).

Table 5.1. Demographics for study participants in the North York Moors National Park (NYMNP) by behavioural group.

Behavioural group	Farm type	Farm size (acres)	Gender	Age
Previously in AES	Arable (mixed)	500	Male	40
	Arable (mixed)	1040	Male	49
	Arable	1000	Male	60
	Dairy	360	Male	32
	Dairy	117	Male/Female	M=51, F=47
	Dairy	124	Male	47
	LFA grazing	166	Male	55
	LFA grazing	360	Male/Female	M=57, F=75
	LFA grazing	260	Female	Not given
	LFA grazing	360	Male	52
	LFA grazing	215	Male	48
	Lowland grazing	510	Male	65
	Lowland grazing	250	Male/Male	M1=38, M2=80
	Lowland grazing	190	Male	66

Never been in AES	Arable	500	Male	43
	Dairy	540	Male	69
	Dairy	500	Male	65
	LFA grazing	120	Female	77
	Lowland grazing	750	Male	54
	Lowland grazing	83	Male	63
	Lowland grazing	300	Male	32
Currently in CSS	Arable	140	Male	68
	Arable	165	Male	57
	Dairy	130	Male	55
	LFA grazing	400	Male	59
	LFA grazing	313	Female	33
	LFA grazing	350	Female	53
	Lowland grazing	46	Female	69
	Lowland grazing	135	Female	Not given
	Lowland grazing	321	Male	56
	Lowland grazing	150	Male	52
Currently in ESS	Arable (mixed)	335	Male/Female	M=67, F=64
	Arable	600	Male	57
	Dairy	250	Male	53
	Dairy	550	Male	62
	Dairy	350	Male	Not given
	LFA grazing	700	Female	62
	LFA grazing	270	Male	38
	LFA grazing	300	Male	64
	Lowland grazing	300	Male	52
	Lowland grazing	300	Male/Male	M1=55, M2=78
	Lowland grazing	900	Male	45

5.3.2. Interviewing procedures and analysis

Semi-structured interviews, lasting on average 57 minutes, were conducted on a face-to-face basis in the participant’s home using a pre-defined interview guide that was flexible enough to allow interviewees to discuss issues arising throughout the interview. Questions varied slightly between the four groups to reflect differences in current and historic willingness to participate. Through the interviews, attitudes towards AES were explored along with actual and perceived barriers to uptake. Other areas explored included overcoming barriers to uptake and the role of the NYMNPA in helping break down barriers to the uptake of AES.

A grounded theory approach (Glaser and Strauss, 1967) was used to gain an understanding of participants' perceptions towards AES. In-depth interviews were digitally recorded, fully transcribed and analysed using thematic analysis techniques (Castleberry and Nolen, 2018). Analysis was performed through a process of (i) reading and familiarization with the interview transcripts and (ii) completing coding to identify reasons for joining and leaving AES, the barriers to the uptake of CSS within the North York Moors National Park (NYMNP), ways to overcome barriers and, the role that the National Park Authority (NPA) could play in overcoming barriers. For each individual code, all instances of text were collated where that code appeared in the dataset, codes were clustered together, and themes developed. The themes were revised by coding and collating more data from the original interview transcripts and the number and percentage of all participants who mentioned a theme were recorded for each theme. Each theme was then analysed to identify primary reasons for AES participation, positive and negative experiences of AES, barriers to uptake of the CSS and ways of overcoming barriers, including the role of the NPA. In order to increase the reliability and validity of the process the same researcher undertook all the fieldwork. A co-author, who attended ~70% of the interviews and read all transcripts, reviewed and verified the themes identified in this study.

2.4. Results

Whilst the focus of this paper is on barriers and ways to overcome the barriers to CSS uptake, it begins with an overview of the main motivating factors farmers gave for making the transition from ESS to CSS. Participants were able to give more than one reason for entering CSS and the study found there are often several factors influencing the decision-making process. Throughout the interviews, four primary themes emerged as motivations for entering CSS, namely, goodness of fit, financial, environmental and forward thinking (Fig. 2). 'Goodness of Fit', i.e., how well a scheme fits with existing farm-management plans, is seen as a motivator for those transitioning to CSS and as a barrier to entry for those who have never or have previously been in AES. For organic farmers and those using extensive farming practices, farmers were able to gain entry to the scheme with minimum changes to existing practices. Arable farmers found the design of CSS to be better than the ESS as it offers options which fit their farming system with minimum change to practice e.g., Option AB2: Basic overwinter stubble, which requires farmers to leave stubble from harvest to 15th February the following year (ca. 6 months), is something they were already doing.

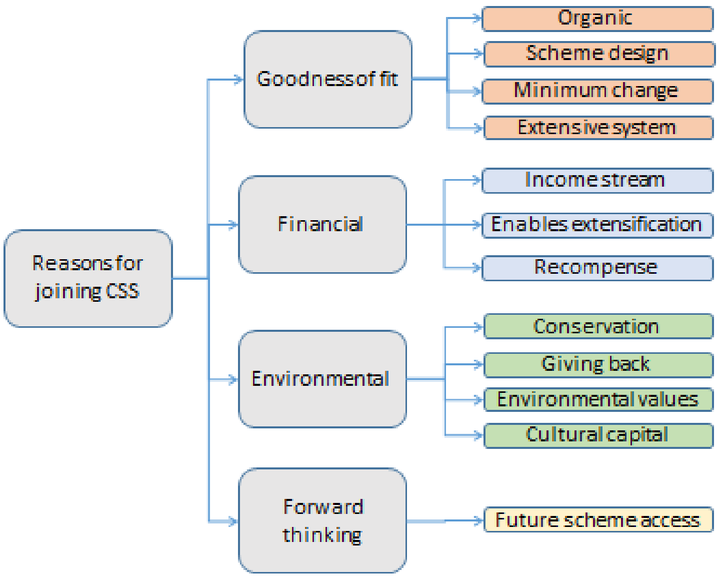

Figure 5.2: Reasons for farmers within the North York Moors National Park joining the Countryside Stewardship Scheme.

Financial incentives are seen by some as providing an income stream, but for others they are viewed as a means of recompense for extensive farming systems and the provision of environmental benefits rather than additional profit to the business. “We couldn’t farm it like this to look after the grasses without payments, we would have to intensify and we don’t want to do that”, (LFA grazing, female, 33).

Farmers who cite environmental motivations have strong views on conservation and feel the need to give back to nature and preserve the habitat, including the cultural capital i.e., farm buildings and stone walls, of the landscape in which they farm. “We want to farm in a way that we are giving a little bit back as well as using it to make a living", (LFA grazing, female, 53). Environmental motivations, whilst being a standalone incentive, are also reflected in both the goodness of fit and financial categories with scheme design and financial recompense enabling organic and extensive farming to occur with minimal change to farming practice.

'Forward thinkers' recognised a shift in policy towards a greener agricultural landscape where farmers will be required to deliver more in the way of public goods. In anticipation of this, they have embraced AES in the hope that a willingness to participate will ensure inclusion in schemes that arise following changes to UK agricultural policy. "To be honest you could see the writing on the wall a number of years ago, so I thought if we get into a scheme for whatever it means at least we have ticked that box", (Arable, male, 59). Many farmers, for many different reasons, have been unable to overcome barriers to joining a CSS and so, on ending their ESS contract, have left AES.

5.4.1. Barriers to the uptake of the Countryside Stewardship Scheme.

Barriers to the uptake of CSS in the NYMNP can be grouped into six main themes, previous ESS experience, financial, scheme administration, goodness of fit to the current farming system, a lack of choice and personal reasons affecting the farmer's decision (Table 5.2).

Table 5.2: Barriers to the uptake of the Countryside Stewardship Scheme within the North York Moors National Park.

ESS experience	Financial	Scheme admin	Goodness of fit	No choice	Personal
Late payments	Low financial incentive	Risk of penalties	No goodness of fit	No choice, invitation only	Uncertainty over tenancy
Risk of penalties	Financial risk	Complexity of paperwork and options	No benefit to the farm	No options available	No recognition
Lack of communication	High transaction costs	Need private advisor	Focus moving from production to conservation		Against personal good farmer principles
No goodness of fit		Too restrictive			Interference on farm
		No continuity between schemes			
		Too bureaucratic			

5.4.2. ESS experience

Of the fifteen farmers leaving AES after previously being in ESS, only one had solely negative experiences with the scheme, three had solely positive things to say and the remaining eleven had mixed views. Despite many positive perceptions of ESS all have since left AES, some because of their experiences of ESS but most for reasons beyond their control. The negative experiences of ESS are also reflected in the barriers to joining CSS indicating a lack of lessons learned when designing and implementing the CSS. Negative experiences of the ESS predominantly focus around:

(i) Payments; “payments were usually late. I think people are waiting years, people are going mad about it” (LFA grazing, female).

(ii) The risk of penalties; “on the North York Moors Farm Scheme [NYMFS], if there was something wrong, we talked about it and I put it right whereas with them [ESS

administrators], you're penalised, it's either 3% or 5% off your single farm payment" (LFA grazing, female, 67),

(iii) The inability to communicate with the relevant authority; "You cannot get an answer from the Rural Payments Agency (RPA) or Defra. It goes around in circles. In three weeks, three months, or in some cases, three years later, you'll get a reply", (Lowland grazing, male, 65) and,

(iv) No goodness of fit to the farming system; "We went into ESS once the Farm Scheme finished. That sort of came to its end [first 5-year contract] and we looked at the dos and don'ts of what we had to do to reapply and it didn't sort of fit into our way of farming so we didn't bother with it", (LFA grazing, male, 48).

Those who have not transferred to CSS despite having positive or mixed views on ESS have either, enquired and decided not to apply for CSS, or have applied and been refused entry as they were not in a target area. Eleven of the 42 participants of this study are currently still in ESS. When asked what they plan to do when their current contract expires, around two-thirds stated they would look at their eligibility for a CSS contract, about a quarter stated they were unsure and only one stated they would leave AES. Of those stating they would look at their eligibility for CSS, one (Arable, male, 57) is confident that they will gain entry into a scheme, albeit with a tweak to farming practice and one strongly feels that they will not be eligible due to their being no options available for their upland system (LFA grazing, female, 52). All others are unsure of their eligibility to transfer from ESS to CSS.

5.4.3. Financial

Farmers found payments for options in CSS to be lower than in ESS creating a major barrier to participation. For example, financial rewards offered for CSS contracts were either less than for ESS contracts or increased restrictions and administrative burdens meaning that private transactions costs outweighed financial incentives for participation. "We were going to get about £850 where we'd been getting £7,000 before and we had to do a lot more record keeping and book-keeping. It was a lot more onerous and time-consuming, so we just said it was not worth it", (Lowland grazing, male, 65).

"We have spoken to a few of the farmers that are a couple of years into some of those schemes and have looked at it and thought 'I don't think it's worth it' because the financial reward has gone and all the hoops to jump through are still there", (LFA grazing, Male, 38).

5.4.4. Scheme design

The complexity of the paperwork associated with applying and reporting on CSS rates high as a barrier to entry. The complex nature of the online application system increases the need to use private advisors in order to reduce risk to not gaining entry, but this also increases the financial burden and risk on the farmer.

"The amount of paperwork is a significant barrier; all it is doing is opening it up for a paid consultant. I am not against consultants, but this money is meant for farmers", (Arable, male, 49).

There were also similarities between the barriers cited by those preparing to leave ESS and the experiences of those currently holding CSS contracts.

"It cost us a fortune because he [advisor] was trying to ring them and we got charged each time, he knocked 25% off and it was still over £1,000" (LFA grazing, female, 33).

"I found it quite hard, I measured my time, 20 hours' solid work went into the application and that's like measuring things and taking photographs, taking soil samples sending off soil samples, writing out reports" (Dairy, male, 55).

Levels of interaction between the farmer and the administrating agency, in most cases Natural England (NE), have significantly influenced perceptions of the scheme. Those experiencing proactive behaviours from advisors report positive experiences of the scheme and the administrative process.

"We've always found Natural England really helpful. And of the two, out of the RPA and Natural England, they're probably easier to deal with", (LFA grazing, female, 53).

However, a lack of face-to-face advisory visits, communication regarding late payments, and a lack of flexibility significantly affect farmer perceptions of the scheme.

"The truth is they have no hands-on deck to come and do it in person and that's the challenge", (Lowland grazing, male, 56).

"I have been pushing them but no response because everyone is tied up with the May 15th deadline, nightmare, I wouldn't have done it if I had known this. It is really impacting on the farms cash flow and making me cross, why should I do the rest of it", (Lowland grazing, male).

"Even the inspector said 'this is ridiculous. I'm going to try and see what I can do'. They couldn't because its EU rules, we had marked it as being there on the map, and it had to be there otherwise you had not followed through. There was a lack of flexibility", (LFA grazing, female, 53).

5.4.5. Goodness of fit

Previous schemes have supported farming systems and provided benefits to the farm whilst CSS is seen by some as shifting in focus from options which support the farming system to those that primarily focus on conservation.

"I couldn't see that it was going to be the same benefits as the previous scheme had. I don't think there were any capital works", (Dairy, male, 40).

5.4.6. *No choice*

Some long-term AES participants express a desire to continue in a scheme but had no choice but to leave as there were no options available to them or they were not in a target area.

"I rung Defra up and said look we want to know what's happening with this scheme we're coming to the end of it we'll have to make some decisions over what we're going to do farming wise what's happening then they informed me then oh we're sorry Mr […..] it is invitation only. We are only taking on the farms where we think it is necessary", (Lowland grazing, males, 38/80).

5.4.7. *Personal reasons*

Some will not make the transition to CSS due to personal reasons, for example, some do not want people interfering on the farm, some felt there is a risk being tenant farmers and for others it is counter to their beliefs on what a good farmer should be, as shown below.

"We haven't thought about it because one thing we don't want is people coming in and telling us what to do" (Mixed, male/female, 76/64).

"We're back to being a tenant farmer. I didn't want to put a lot of capital options in there in case I get kicked off and, suddenly, I've lost that £40,000 investment" (Arable, male, 49).

"They make your life – you're still a tenant, you're still down the ladder, so you're fighting all the time really. The uncertainty doesn't help because, if we sign up for countryside stewardship, he would have to countersign and then he would probably feel that he wanted the rent up" (LFA grazing, female. not given).

"I have always been brought up to farm the place clean and try and keep it weed free and it's just going in to reverse everything that we have ever been taught around farming for the last

10,000 years. Infested with black grass and even found brambles and briars and things growing in some of these flipping game plots. It's not really the way to farm at all" (Arable, male, 60).

5.4.8. Overcoming barriers to CSS uptake

There are similarities between some of the suggestions as to how barriers to joining CSS may be overcome and reasons for joining CSS e.g., scheme design, goodness of fit and financial incentives but here the emergence of more specific suggestions on how barriers to CSS and AES in general can be overcome are shown e.g., the localisation of AES, improved relations with the service provider at a local level, and the provision of training (Fig. 5.3). Clear differences emerge between the suggestions made by those who have never been in schemes and those who have, although there are areas of commonality. Those who have never been in a scheme suggest uptake of AES be increased through the provision of knowledgeable local advisors and the implementation of a simple, localised scheme which benefits production and gives the farmer more control over delivery.

"Just hand the power and the money back to the national parks. I don't know, I just think advisors must, understand both sides of the problem, farming as well as the environmental side" (Dairy, male, 65)

"Advisors must be prepared to "come and having a walk round the farm spending a couple of hours sitting down and saying right well have you thought about this, have you thought about that, what about this one", (Lowland grazing, male, 30's).

The non-AES group feels detached from national schemes, arguing for AES management and administration to be transferred to the NPA and for farmers to have more local control over the delivery of options, “I can’t believe they just haven’t. They’re too far away from us, aren’t they? They’re not on the spot like national parks. I know they’re working with European law and all that, but it really does just need to go back to the national parks”, (Lowland grazing, male, 54)

“As a farmer, my voice is not heard with regard to habitats. If I had more of a say in the management of land in a scheme, I would be much more likely to be interested”, (Dairy, male, 65).

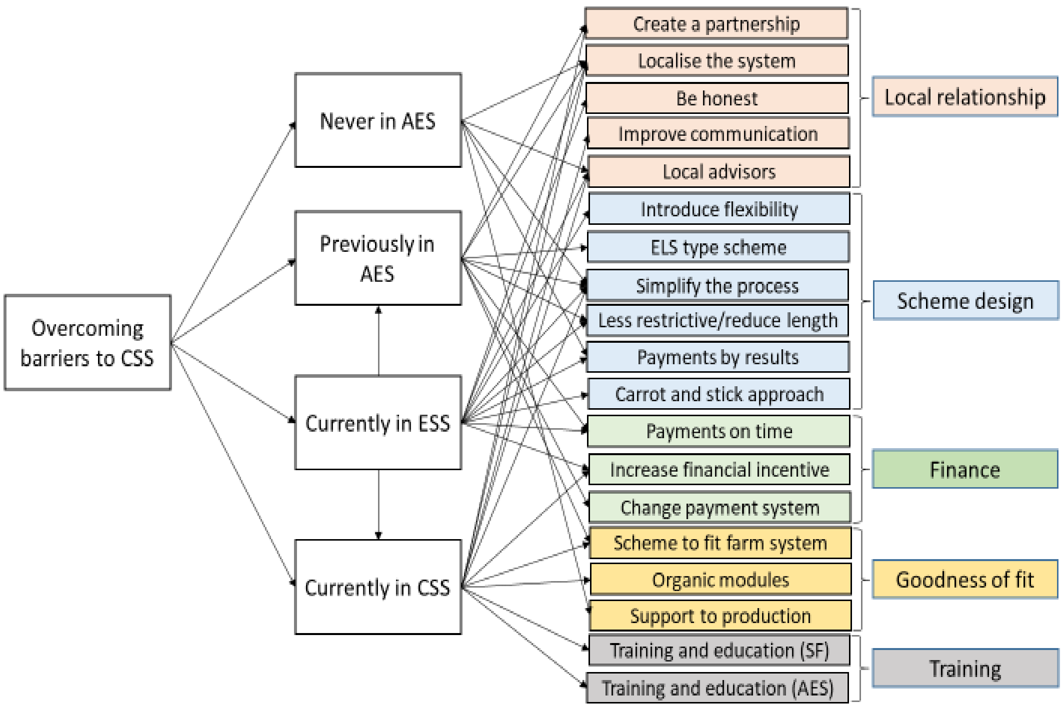

Figure 5.3. Schematic showing pathways to overcoming barriers to the uptake of the Countryside Stewardship Scheme.

The localisation of AES and the simplification of the process were the only two suggestions mentioned by participants in all categories. 50% of respondents advised the greater use of local advisors or a shift to NPA management of schemes due to;

(i) Differences in habitat, “The problems that they’ve got down there [in the lowlands] are different to what we’ve got up on the moors here” (Arable, male, 49),

(ii) Ease of access, “If you’ve got somebody that you can get hold off that’s easy to talk to that knows the area, knows us and we know them and we can get on with then that’s a lot better”, (Lowland grazing, male, 55), and

(iii) Better communication levels and interest, “I would much prefer it if National Park (NP) officers came onto the farm, I’d love to do the walk with them, there would be a 2-way conversation and it is the opportunity for that officer, be it NE or NP, to provide encouragement, I don’t know, just encourage me, incentivise me”, (Lowland grazing, male, age not supplied).

Suggestions for scheme simplification begin with a streamlining of the application process to provide easily accessible option information to the farmer. It then extends into the need for improved advisory services, and clear objectives,

“If it was something straightforward telling us what we could and couldn’t do, we might go find out more detail. I suppose headlines and then you can find out the next bit if you need to”, (Arable, male, 67).

“A bit of professional advice or someone who has actually got a thorough knowledge of the scheme if you’ve not got the time or motivation to actually do it yourself”, (Lowland grazing, male, 65).

“I think if it was simple enough to get. If the government said ‘right, here’s a simple thing, you put a field down to your beet crop or whatever or your wild birds, and we give you a suitable amount of money to cover your expenses of putting it in plus a little bit because you want a profit’, then I’d be ok”, (Arable, male, 43).

Those previously in AES and some of those in ESS, support the localisation and simplification of AES, but additional suggestions made by these groups could easily be implemented, thereby reducing barriers to uptake. For example, the development of a closer working partnership between the farmer and the scheme provider.

“Although it [NYMFS] was farmer-led in some ways, it was a partnership. Whereas with the entry-level thing, you signed up and you weren’t in any partnership with anybody”, (Lowland grazing, male, 66).

Suggestions to move back to a less restrictive, entry level approach indicates a preference for the broad and shallow approach to AES over the more targeted approach taken by CSS. One suggestion supports the ‘payments for public goods approach’ through a move away from income foregone.

“This income foregone is crazy because we are all pleading that we are not getting any income so we are not going to be able to put in for much money, are we? Let’s get paid what we are worth. We need to be paid what it costs to run these spots, but these spots can offer so much, we can provide an environment for everyone to see and enjoy and we can provide food as well”, (Lowland grazing, male, 66).

In addition to the development of closer relationships and partnerships, and the move to a simpler, localised scheme, more environmentally focused farmers also demonstrate a willingness to receive training and advice on sustainable farming, the delivery of environmental goods and on the government narrative.

“We have autumn and spring calvers and at the moment, we are finding it really hard to keep the autumn calvers’ weight on. It would be a bit of education about that and also marketing of your beasts”, (LFA grazing, female, 53), “I totally agree that things are not explained enough and it would be good, it is all part of the story that needs to be told. It would make a huge difference to me if they were”, (Lowland grazing, male, age not provided).

5.4.9. The role of the NPAs in overcoming barriers to CSS uptake

Participants were asked to explain what role they thought the NPA had to play in breaking down barriers and expand upon the suggestion to localise AES. Location (inside the NP) and experience of previous schemes (NYMFS) have positively influenced perceptions on how an AES scheme could and should be run. Whilst 43% of the suggestions are linked to the NPA's role in breaking down barriers to the uptake of CSS, most suggestions (58%) recommend a move away from a national scheme towards a local-led scheme (Fig. 5.4). A belief that a NPA-led scheme would have greater uptake than current ESS and CSS is linked to personal experience with NPA staff and an opinion that the NPA has a responsibility to preserve the natural and cultural heritage of the park. Staff are seen as having good local knowledge, good relationships with local farmer and the experience to deliver high quality public goods.

"The National Parks know their local area which helps tremendously, they work with the local area and what is needed in that area, what needs conserving, what needs looking after, you know", (LFA grazing, male, 48),

"I think the NPA have a leading role here. I mean, years ago they had a farm scheme which was the envy. I mean, we were never in it because we weren't in the right area at the time, but friends that were said it was marvellous. You'd got a co-ordinator and you had a point of contact and a point of focus", (Lowland grazing, male, 65).

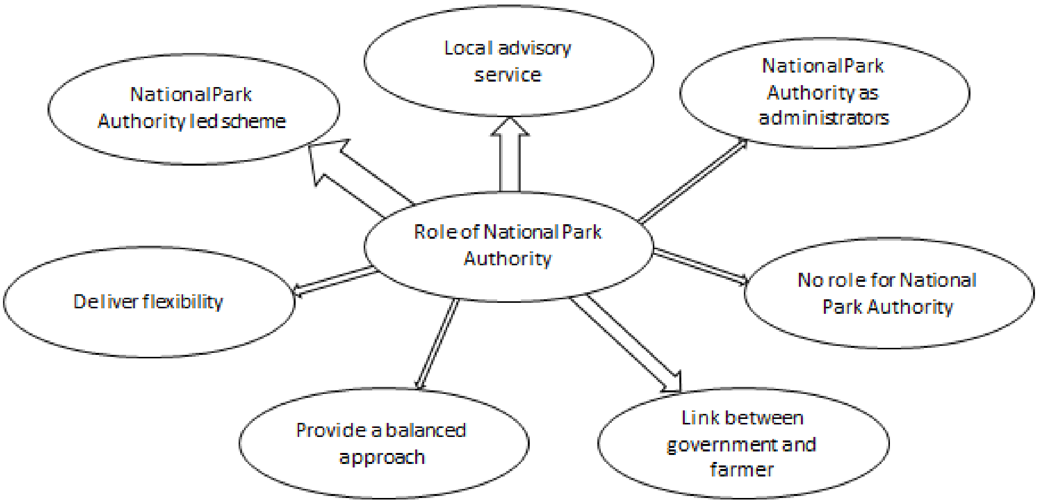

Figure 5.4. The potential role of National Park Authorities in overcoming barriers to the uptake of the Countryside Stewardship Scheme identified through farmer questioning[11].

Confidence in the NPA is forged through the belief that they are best placed to tackle the challenges faced by communities living within the park boundaries, "bodies like the national park should have a chance to get us into these schemes because I think there would be a big uptake. You need to have confidence in whoever is supervising it and in charge of it and if it's just a faceless somebody sat in an office down south or wherever who doesn't have any real experience of areas like this or the countryside", (LFA grazing, female, 67).).

Whilst most participants show a preference towards a local scheme, an equal number suggest compromise through the provision of local advisors or go-betweens. The NPA could act as a link between the farmer and the government, and they could provide advice to the government on goodness of fit of schemes to the national park.

[11] The size of the arrows represents the strength of response.

“There is definitely a role. I see the NP as a link between the farmer and the government. I feel that in the farmer/government link there is something missing there. If we could have the NP in the middle, I reckon that would be a big help”, (Lowland grazing, male, 66).

“Probably the useful thing the NP could do is lobbying on how these schemes look, making sure that the scheme as a whole fits the national park”, (Dairy, male, 40).

The NPA could potentially ease the administrative burden on both the farmer and the scheme provider i.e., Defra, and add a level of flexibility into the system, by acting as an agent or intermediary between the farmer and the scheme provider.

“Someone could come who would be linked into Defra’s system, we could go through the application, help fill it and check that it was okay making sure that there were no glitches in the system”, (Lowland grazing, male, 56).

“I think the NP could be those people that could be the ones to deliver that flexibility in that they would have a licence to enter Defra’s system and amend an application”, (Lowland grazing, male, 56).

In summary, all participants in this study see a role for NPAs in future AES management and delivery, be it as the primary deliverer of AES or as a link between the government and the farmer in both advisory and administrative roles.

2.5. Discussion

5.5.1. Barriers to CSS uptake

The number of farmers and the area of agricultural land involved in AES significantly reduced during the period 2014-2018. However, not all farmers chose to leave AES on completion of their ESS contract. This study endeavours to identify the main reasons farmers’ transition from ESS to CSS and the barriers preventing that transition. The research confirms the findings of other studies (Falconer, 2000; Morris and Potter, 1995; Van Herzele et al., 2013), which show that the farmer's decision to participate, or not, is influenced, not by an individual factor, but by a complex mix of personal, family and farm business factors. Goodness of fit to current farming practice, financial incentives and environmental factors all feature heavily in the farmer's decision-making making process and farmers can be categorised based on the priorities they give to these categories (Morris and Potter, 1995; Wilson and Hart, 2000). Whilst the CSS adopters cite all three of these factors as a reason for joining CSS, a common link running throughout is a concern for the environment. This places them in the category described by Morris and Potter (1995) as the 'active adopter'. These farmers are often the most committed participants; they are often conservationist farms with a history of countryside management activity engaging in extensive farming practices and often contributing more to the environment than that required of standard AES prescriptions. The 'forward thinkers', who have risen out of the uncertainty surrounding the future of agricultural policy in the UK, are similar to farmers described by the Wales Rural Observatory (2011) as those prepared to consider agri-environment participation as a means to increase the resilience of their businesses. They may not be as environmentally proactive as the 'active adopter' but they foresee the need to adopt environmental actions as part of a future orientated business decision. The 'active adopters' and the 'forward thinkers' are prepared to overcome barriers to uptake, persisting with scheme delivery even when transaction costs are high, and their experiences of CSS are negative.

From a Transaction Cost Economics (TCE) point of view, AES can be seen as a contractual mechanism for the transaction of environmental goods and services between the farmer, as seller, and society, represented by the public authorities, as buyer (Mettepenningen et al., 2009). Transaction costs (TCs) can be defined as the costs arising from organising the transfer of goods and services between two agents, in the case of AES, between the farmer and society

(Cheung, 1992). In AES contracts, TCs will be incurred in both the public sector (by the government departments or scheme provider) and in the private sector, by the participants (or potential participants) in the scheme (Falconer, 2000). TCs for the scheme provider arise through scheme administration namely, notification and communication with the European Commission, contracting, organizing payments to farmers, monitoring, control, evaluation activities and provision of advice and support to farmers. (Mettepenningen et al., 2009; Mettepenningen et al., 2011). In the private sector, TCs can be grouped into three main areas, search costs, negotiation costs and monitoring and enforcement costs (Dahlman, 1979, Hobbs, 2004). In voluntary AES, where participants are expected to deliver management options, payments must sufficiently compensate the farmer for TCs if there is to be no adverse income effect of scheme involvement (Falconer, 2000). National governments are increasingly needing to do more with less and are therefore utilising low cost, high quality, policy solutions to transfer responsibility to an increasing diverse array of non-state actors, including farmers participating in voluntary AES (Janssen and Estevez, 2013). This approach promotes the transformation of traditional government, which is linked to activities backed by formal authorities (Rosenau, 1992) to governance which can be described as "the setting of rules, the application of rules, and the enforcement of rules." (Kjær, 2004; Kluvankova-Oravska et al., 2009). In governance, actors are searching for control, steering, and accountability (Konijnendijk van den Bosch, 2015) which allow them to govern at a distance through the use of an 'audit culture' (Power, 2003) which uses inspections (or the threat of them) to 'remake' farmers into 'responsibilised' business individuals who will become increasingly empowered to discipline themselves (Ferguson and Gupta, 2002; Kovács, 2015). In England, even scheme names imply a transference of responsibility through the use of the word 'stewardship' which can be described as looking after something 'in trust' for someone else, be that nature, society or future generations (Worrell and Appleby, 2000).

These findings support Kovács (2015), who found farmers to have a fear of the state as a result of their past experience of the audit process which increased financial risk through the enforcement of administrative rules. This process appeared to many farmers as being irrelevant to the practice of agriculture. In this study, those deciding not to transition from ESS to CSS identify several barriers, linked to a perceived increase in TCs, preventing them from applying to join the scheme. Negative experiences are encountered during the ESS contract predominantly linked to bureaucratic scheme administration. Levels of trust between the farmer and government agencies are being eroded though the prescriptive nature of the scheme and perceived increases in levels of government control and evaluation of farmers (Mettepenningen et al., 2013). This research shows late payments, inspections, penalties and the inability to communicate with the scheme provider creating division, and reduced levels of trust, between the scheme administrator and the deliverer. An increase in the complexity of the CSS application process combined with the increased need for auditing activities, including stocking diaries, and photographic evidence, increases financial and time input costs for farmers, elevating private transaction costs to levels where farmers no longer deem scheme participation to be viable. These increases in input requirements, combined with a decrease in financial incentives, elevate private transaction costs to levels where farmers no longer deem scheme participation viable (Falconer, 2000). Farmers in the study perceive there to be an element of risk associated with the application process, predominantly due to the complexity of the paperwork. These perceptions of risk are accentuated by the multiple, and often conflicting, roles that government actors play as regulations change, and responsibilities shift (Taylor and Van Grieken, 2015).

Farmers aim to reduce risk levels through the employment of private consultants to prepare the paperwork, provide technical advice and reduce the administrative burden by writing the application. In the case of CSS, government-funded consultants were not freely available, and the use of private consultants is necessary. This out-sourcing of paperwork to private consultants may also be viewed as a diffusion of responsibility away from government to the private sector (Kovács, 2015). Taylor and Van Grieken (2015) found the provision of extension officers in support to the application process reduces risk and provides local legitimacy to the scheme. Whilst, some participants are willing to accept additional transaction costs associated with the use of a private consultant, many find the additional costs and layers of bureaucracy outweighing the benefits of being in the scheme and therefore fail to apply. The use of private consultants may reduce the administrative burden on the farmer, but the consultancy cost is high and they also weaken the strength of the relationship between the scheme administrator and the scheme deliverer creating a 'them and us' situation. Scheme administrators are viewed as those who conduct inspections and issue penalties, policing instead of nurturing, punishing instead of encouraging and this creates barriers farmers find difficult to overcome.

According to Wilson and Hart (2000), a lack of scheme flexibility and the resulting fact that the schemes do not always fit into farm management plans are main reasons why farmers do not engage further in voluntary AESs, choosing only to implement the schemes on their most suitable lands (Mettepenningen et al., 2013). These findings support this research with no 'goodness of fit' to the farming system featuring high on the list of barriers to adoption stated by study participants. AES contracts are commonly criticised for representing 'easy money', because they often entail activities that are already ongoing at the farm (Sutherland, 2010). However, this ease of entry and goodness of fit to the farming system enables entry to a scheme and whilst it may not necessarily enhance biodiversity or increase carbon sequestration, it stops further degradation and agricultural intensification on the land (Arnott et al., 2019). The barriers to uptake revealed in our findings support, but do not necessarily add to, existing literature on the topic (Wilson and Hart, 2000; Sutherland, 2010; Mettepenningen et al., 2013; Wynne-Jones, 2013; Kragt et al., 2014). However, by highlighting similarities between these barriers and those shown in existing literature, this study is able to give insight into how policymakers potentially misunderstood or ignored the literature when designing the CSS, leading to the substantial reduction in uptake.

5.5.2. Overcoming barriers to CSS uptake

Responsibility for the reduction in AES coverage since the introduction of the CSS must lie with the both the policymaker and the scheme provider. Above it is shown how poor administration i.e., late payments and poor communication channels, have increased TCs and impeded participation. Here changes to scheme design and the levels at which the scheme is delivered and administered, are discussed to determine how future schemes could enhance participation and effectiveness. In the case of the CSS, scheme design has meant that for many respondents to this study, financial incentives to participate are much lower under CSS than in ESS and TCs, personal to the farmer, have been seen to increase. Participants suggest barriers can be overcome through a reduction in TCs, achieved through the localisation of national schemes. Decentralisation of environmental policies to a local level has been a strategy employed by governments to implement programmes and resolve environmental conflict in both EU and US aquatic ecosystems (Koehler and Koontz, 2008; Lurie and Hibbard, 2008; Page and Kaika, 2003; Prager, 2010). In Australia, the government, since the 1990's, has encouraged the devolution of natural resource planning and management responsibilities to catchment or regional level organisations. These regional organisations have become the primary means of delivering environmental programmes on agricultural landscapes (Lockwood and Davidson, 2010; Robinson and Taylor, 2009). Shortle et al. (2001) argue that economic efficiency in the provision of a public good is best served by delegating responsibility for the provision of the good to the lowest level of government that encompasses all the associated costs and benefits. Generally, it is in the political interest of the local authority to develop local policies that are sensitive to local preferences (Shortle et al., 2001) and here it is shown that perceptions of the NYMNPA as deliverers of AES, are high, partly due to the belief that the NYMFS met the needs of local farmers. Similar experiences are noted in the Yorkshire Dales National Park where a Results-Based Agri-Environment Pilot Scheme, managed by Natural England and the NPA are meeting the needs of the farmer by ensuring that farmers own and understand the results and scheme outcomes, rather than simply following prescriptions, promoting genuine behaviour change (Chaplin et al., 2019). Farmers can manage as they see fit to achieve outcomes in their specific location, transferring power and ownership to the farmer. This allows them the freedom to use their own local knowledge and expertise, providing flexibility at the field, farm, local, regional level – rather than a national 'one-size fits all' set of prescriptions (Chaplin et al., 2019) and is one of the methods suggested by the participants of this study to overcome barriers to AES uptake.

A move to a payment by results (PBR) style of delivering AES objectives supports a neoliberal governance approach as it gives farmers more autonomy. Current agricultural policy requires farmers to invest in computers and overcome internet connection difficulties in order to submit the relevant paperwork needed to claim BPS and AES payments and this is part and parcel of modernising farmers through a development and valuation of their skills base (Kovács, 2015). A PBR approach sees the value of the payment directly linked to the level of environmental outcomes achieved, not to the management inputs/actions undertaken. This in turn means that there is no need for evidence that prescriptions have been met as payment is based on the results not inputs/actions (Chaplin, 2015). Farmers have the freedom to use their own local knowledge and expertise however, the onus is placed on them to seek advice and to improve their skills, and knowledge to enable them to deliver the results (Chaplin, 2015). Participants in PBR schemes are required to conduct self-assessments (Chaplin, 2015) which is in keeping with a neoliberal governance approach which aims to pass responsibility to self-monitor and self-discipline to the individual (Kovács, 2015).

The complexity of the CSS is a major problem for many farmers when it comes to dealing with the associated administrative tasks. Outsourcing to a private consultant reduces the responsibility and risk associated with possible mistakes but it can lead to financial disadvantages to the farmer as the percentage of the compensatory payment lost to TCs increase (Vernimmen et al., 2000). Other factors such as the personal skill of the farmer, their attitude towards administrative processes, their degree of risk aversion and their willingness to be independent from paid services all influence the decision to outsource the administrative burden and ultimately the decision to participate in the AES scheme (Vernimmen et al., 2000). Bureaucracy surrounding CSS can lead to farmers feeling powerless (Vernimmen et al., 2000) therefore policymakers must be aware that rising administrative cost will eventually isolate the farmer and, as shown here with the CSS, lead to a reduction in scheme participants. McCann and Claassen (2016) suggest that efforts to simplify forms and procedures may be a cost-effective way to increase participation. Agree with these findings, it is also suggested that in addition to a simplification of the system, the provision of a locally based advisory team would significantly reduce both the financial and time TCs borne by the farmer and further increase participation.

This study shows farmers reflecting on previous experiences of the local AES run by the NPA and arguing that the primary means of reducing TCs and overcoming barriers to the uptake of CSS would be to return the management and administration responsibilities for AES to a local level, in this case the NPA. Farmer experiences with the local scheme concur with the findings of Mettepenningen and Van Huylenbroeck (2009) who suggest that the more decentralised a policy is, the lower the private TCs will be, due to a reduction in the paperwork. Mettepenningen and Van Huylenbroeck (2009) also note that decentralisation can result in greater accuracy of payments to outcome and therefore also a better environmental outcome. The decentralisation of resource governance to other actors such as NPAs is one of the key dimensions underpinning a neoliberal governance approach (Gregory, 2018) and would therefore support the UK government's neoliberal conceptions of autonomy (Stock et al., 2014).

Neoliberal governance, in its early stages can be divisive as its policy emphasis is mainly on marketisation, the 'level playing field' and a minimal state (Larner and Craig, 2005). In New Zealand, pure neoliberalism has been replaced by a new form of joined up, inclusive governance characterised by relationships of collaboration, trust and, above all, partnership (Larner and Craig, 2005). Improved relationships and the formation of local partnerships are suggestions put forward by participants of this study to overcoming barriers to participation in AES. All farmers who participated in the NYMFS reported receiving payments in a timely fashion and stated that all works completed under the scheme were still in place and were being maintained. Greater farmer participation in the decision-making process and a better understanding, at the provider level, of local needs and desires arises through a close relationship between the scheme provider and the deliver.

With the NPA-led local scheme the relationship was close and personal whereas, with the CSS the relationship is fractured and distant. Farmers have little or no say in the decision-making process and policymakers appear to have little or no understanding of the needs and desires of the farmer, or of the land and its conservation needs. The 'one scheme fits all' approach of national schemes does not address local needs; every district is different and within districts every farm has varying needs and desires. The decentralised approach taken the NPA-led local scheme created a dialogue between the farmer and the advisor, the farmer understood the overarching objectives of the scheme and the NPA, by meeting the needs and desires of the farmer in the scheme design, increased the relevance of NPA to local people and delivered on the key aspects of decentralisation theory.

Here the barriers to CSS uptake are discussed and the TCs borne by the farmer are highlighted. However, any AES transaction generates TCs for the state too (Falconer et al., 2001). Consequently, reducing farmers' transaction costs may initially increase the state's costs as there may be costs associated with training, mentoring and the provision of local. There are currently a range of locally governed schemes in place across the UK e.g., Local Action Groups and the LEADER programme, but none is fully developed enough to fully implement a spatially decentralised policy within local areas that can take account of the values and preferences of stakeholders and make the necessary trade-offs in a transparent, accountable and democratic way (Dwyer and Hodge, 2016; Hodge, 2017). Clearly CSS, in its current format, is discouraging participation in AES and this has the potential to significantly impact on biodiversity and the way in which land is managed within England. As the UK moves towards the proposed ELMS, due to replace both the CSS and BPS in 2027, policymakers can create an AES policy structure that will increase participation and deliver on biodiversity, water quality, flood risk management and climate change and tree planting targets through engagement at a local level. The findings of this study which show how the NYMNPA has delivered a decentralised scheme to good effect within the North York Moors support Clarke (2015) who suggests that NPAs come closest to what is required to deliver a spatially decentralised policy, but the approach would need to extend beyond the protected areas in principle across all areas.

1. Conclusion

To conclude, the structure of the CSS has significantly increased private transaction costs for farmers and this in turn has led to an exodus of farmers from AES. The number of farmers and land within AES in England is likely to continue dropping as the ESS ends in 2023. The 'one size fits all' approach to AES, currently taken by AES policymakers, blocks some from participation and the complexity of the scheme isolates the farmers from the scheme provider.

If the relationship between the scheme provider and deliverer is distant and fractured there is no trust and the government agency is seen more as an enforcer than a partner. Policymakers have an opportunity to deliver on the UK governments neoliberal conceptions of autonomy that are seen to underpin the government's approach to both agricultural and environmental policy (Stock et al., 2014) and increase participation in AES through the decentralisation of AES policy. However, this would likely require a significant restructuring of government agencies and would initially increase public transaction costs. It can be argued that the NPAs come closest to what is required to deliver a spatially decentralised policy and it is possible they could provide the location and infrastructure to implement devolved ELMS pilot schemes.

Acknowledgements

The researchers would like to thank all participants for the giving of their time to contribute to this study. Special thanks go to Rachel Smith, Judith Seaton and Ann Stafford for their assistance with transcriptions.

Funding: This work was supported by the FLEXIS (Flexible Integrated Energy Systems) programme, an operation led by Cardiff University, Swansea University and the University of South Wales, and funded through the Welsh European Funding Office (WEFO).

Conflict of interest

The authors confirm that there is no conflict of interest with the networks, organisations, and data centres referred to in the paper.

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Chapter 6

Agricultural policy change and the future of UK farming – A survey of farmer attitudes

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D.A. designed and conceived the research. D.A. conducted the analysis of the data and prepared the manuscript. All authors discussed results and contributed to preparation of the manuscript.

6.1. Introduction

The UK joined the Common Market in 1973 and in doing so, the UK support system, established under the 1947 Agriculture Act, was progressively subsumed into the Common Agricultural Policy (CAP). Initially, CAP support systems were seen to be effectively supplying affordable food to European Union (EU) citizens and delivering a fair standard of living for farmers (Termeer and Breeman, 2013). However, by the 1980's its market and structural support policies were held responsible for the intensification of farming practices, and the concentration of production from fewer, more specialised farms (Bignal et al., 2001). This agricultural intensification was directly linked to population declines in farmland bird species (Donald et al., 2002), increased habitat degradation, biodiversity and pollinator losses (Young et al, 2005; Decourtye et al., 2010), nutrient runoff and sedimentation of waterways (Zhang et al. 2007), and considerable increases in greenhouse gas (GHG) emissions (Burney et al., 2010). These negative externalities prompted change and agricultural policy has, since the 1990s, been steadily shifting from a 'productivist' to a 'post-productivist' ethos, but evidence suggests that farmer attitudes may not necessarily have changed in line with policy (Gorton et al., 2008). The Fichler reform (2003), which decoupled payments from production, seen many farmers adopt a productivist 'business as usual' approach, engaging policy reform measures only where there was no conflict with their primary objective of food production (Walford, 2003). Others adapted their farming practices to meet challenges presented by the reforms by lowering stocking rates, allowing for extensive using less labour, joining AES and looked for alternative income means through diversification, on and off-farm (Franks, 2006).

In March 2019, the UK is due to leave the EU. This is likely to lead to the most significant change in agricultural policy since joining the Common Market in 1973. The current payment support system will cease to exist and farmers and land managers will in future be offered payments for the delivery of "public goods", such as better air and water quality, improved soil health, higher animal welfare standards, public access to the countryside and measures to reduce flooding (UK Government, 2018a). The intent to follow a specific pathway is shaped by farmer identity (Sulemana and James, 2014), the ability to employ survival strategies, including agricultural, structural and income diversification (Meert et al., 20-05) and in the case AES a willingness and ability to take up environmental activities (Mills et al., 2017). Various typologies have been used to explore the decision-making process of farmers and to inform policy design and a farmer's willingness to embrace environmental practices (Darnhofer et al., 2005; Guillem et al., 2012; Hyland et al., 2016). Whilst they may differ in methodology and classification, they all identify differences in values and attitudes between more traditional, "productivist", farmers and those more inclined to embrace environmental practices. These differences in values and attitude were reflected in the voting results of the 2016 EU referendum. Despite the potential for significant challenges to business viability post-Brexit (Grant, 2016a; Grant et al., 2016; Helm, 2017; Dwyer, 2018; Hiram, 2018), >50% surveyed by Farmers Weekly (2017) stated they voted to leave the EU.

If future agricultural policy is to deliver a 'greener' agricultural landscape, whilst supporting sustainable production activities, it will require policy-makers to have a better understanding of farmer motivations and the reasons behind the apparent contradiction between voting preferences and the potential significant challenges to business viability facing farmers. This paper aims to give policymakers a snapshot view of farmer attitudes towards future policy change by identifying farmer attitudes towards Brexit, subsidies, public goods and future farming practices and making links between positive and negative attitudes and demographics.

6.2. Methodology

To assess the attitudes across a broad cross section of UK farmers, a quantitative survey was undertaken between February and May 2018. The structure of the questionnaire began by asking: “What type of information do I need to collect?” (Colosi, 2006). As 53% of farmers voted to leave the EU (Farmers Weekly, 2017), despite the impact it may have on subsidies, this study needed to collect data that identify attitudes, which include participant’s perceptions, feelings, or judgments, in order to assess participant views on a Brexit, the removal of direct subsidies and future farming practices. Through collaboration with the National Farmers Union Wales (NFU Cymru) and an academic expert review, a number of key areas of concern were identified (Colosi, 2006). The questionnaire was then designed around the key concern areas in each section. The use of statements and Likert scales was chosen as it allows for a timelier and more systematic analysis of data collected (Colosi, 2006). The National Farmers Union Wales (NFU) Cymru) and an academic expert panel conducted a review of the survey design, focus and format and the questionnaire was amended before going to farmer pre-test.

A pre-test was conducted with 27 farmers across various sectors, and minor amendments (e.g., to the wording of some questions) were implemented thereafter (Colosi, 2006). The final questionnaire (see Supplementary material), reviewed and approved by the Bangor University Ethics Committee (reference number CNS2017DA01), consisted of several sections. Section one and two elicited socio-demographic information on the farmer and the farm, section three comprised 4 questions relating to current and previous involvement in AES, section four consisted of 44 statements where respondents were asked to express their opinion on a 5-point Likert scale (1 being most negative and 5 being most positive). Scores were summed per demographic category and the mean was used to identify positive or negative attitudes to the subject matter (i.e., Brexit, subsidies, public goods or future farming practices). Section five asked questions on networking and a willingness to collaborate with others, and the final section captured farmers’ general comments. For the purpose of this analysis, the final statements in section four were reduced to 31 as a number of questions asked were similar in design and the questions in section five were not included. Statement responses strongly agree

– strongly disagree were scored one to five, with one being most negative and five being most positive. We aimed to attain a balanced sample that is as representative of the sector as possible, by recruiting the final respondents (n=208) at agricultural shows and events and using snowball sampling, targeted email drops and targeted sampling through social media (Twitter and Facebook).

Data retrieved from the returned questionnaires was summarized using descriptive statistics for Likert data in the statistical package R. One-way Ordinal Regression with cumulative link models (CLM) in R was used to identify differences between demographic groups (age, gender, succession, participation in agri-environment schemes (AES), education, identity, source of diversification income, farm ownership and time farm in family) in response to the individual questions. Where the regression analysis identifies significant ($p<0.05$) differences in responses to questions between demographic sub-groups, they are reported upon in the respective sections. Scores were summed for each of the sections (Attitudes to Brexit, subsidies and future farming practice) and analysis of variance (ANOVA), a commonly used technique to determine a relationship between a continuous response and categorical predictors, and a Tukey Post-Hoc, a secondary analysis performed to determine which levels differ from one another, were used to identify differences between demographic groups. Where significant differences were found, interaction plots which plots the mean (or other summary) of the response for a two-way combination of factors were used to explore the differences (Chambers et al., 1992).

6.3. Results

In total, 208 completed surveys were obtained, representing c.a. 0.2% of the total farmers in the UK, of which only 4 were deemed invalid because of large amounts of missing data.

Results are arranged into the following categories: demographics, attitudes to Brexit, attitudes to subsidies, attitudes to public goods and future farming practices.

6.3.1. Demographics

The snowball sampling method used in this survey aimed to achieve similar response demographics, across farm type and farm size, to those found in national agricultural surveys (Daera, 2017ab; Defra, 2017ab; SG, 2017ab; WG, 2017ab). Table 6.1 shows the percentage of total farm holdings, in each farm type category, for each country of the UK and Table 6.2 shows the percentage of responses in each farm type category achieved by the survey. Responses by category are within 6% of the national average, by farm type, for the less favoured area (LFA) grazing, lowland grazing and dairy categories. In the mixed farm category, we received a higher-than-average response from farmers and in the other category, which includes (horticulture, general cropping, arable, pigs, poultry and other small holdings) we received a lower than national average response. Survey responses, relating to farm size, were similar to national averages in the 20 to 50 hectare (ha) and 50 to 100 ha categories but were under-represented in the <20 ha category and over-represented in the >100 ha category.

Table 6.3 shows the demographic profile of the survey participants. The gender and age breakdown are similar to national averages. In 2016, 84% of farm holders were male and 40% were over 65 with the median age of farm holders being 60 (Defra, 2016). In England, 65% of managers had practical experience rather than a formal agricultural education. A further 16% had basic agricultural training and 20% had full agricultural training (Defra, 2016). The education breakdown of survey participants shows a similar pattern with the greatest percentage being educated on farm. Over 50% identify themselves as business-persons or food producers with only 18% identifying themselves as land custodians. In 2018/19, 42% of farmers in England stated they had a family member as successor to the family business (Defra,

2019) which is similar to the results shown here (48%). Farmers participating in this survey stating they had diversification income was higher (81%) than reported in the farm business survey (65%; Defra, 2019). Seventy-one percent of respondents stated that the farm had been in the family for more than 3 generations.

Farm type	Wales	England	Scotland	Northern Ireland	Mean % of farm type across UK	Response % achieved
LFA grazing	60%	12%	29%	59%	40%	34%
Lowland grazing	12%	30%	6%	20%	17%	23%
Dairy	10%	6%	1%	11%	7%	9%
Mixed	5%	8%	9%	2%	6%	25%
Other	13%	44%	55%	8%	30%	9%
Total	100%	100%	100%	100%	100%	100%

*Table 6.1. Percentage of total farm holdings, in each farm type category, for each country of the UK obtained during the survey. **

* Source: June Agricultural Survey (Daera, 2017a; Defra, 2017a; SG, 2017a; WG, 2017a)

Table 6.2. Number and percentage of total UK farm holdings by farm size categories obtained during the survey. The response % shows the percentage of survey respondents in each category.

Farm size	Number of holdings ('000)	Percentage of total holdings	Response % achieved
< 20 ha	103	*47%*	15%
20-50 ha	41	*19%*	18%
50-100 ha	32	*15%*	23%
>100 ha	41	*19%*	44%
Totals	217	*100%*	100%

Table 6.3. Demographic profile of survey participants.

Attribute	Category	Percentage of total respondents*
Gender	Male	23%
	Female	77%
Age	<35	8%
	35 - 44	21%
	45 -54	13%
	55 - 65	26%
	>65	32%
Nationality	English	59%
	Welsh	33%
	Scottish	6%
	Irish	1%
	British	1%
Highest level of agricultural education	On-farm	40%
	Ag College	32%
	University	23%
	Secondary School	2%

	College	1%
	6th Form College	1%
Identity	Businessperson	29%
	Food producer	22%
	Land custodian	18%
	Land manager	13%
	Smallholder	7%
	Hobby farmer	6%
	Other	4%
Time farm in family	1st generation	17%
	2nd generation	13%
	3-5 generations	38%
	>5 generations	33%
Succession	Family member	48%
	Unsure	39%
	No Successor	11%
	Non-family member	2%
Diversification	Off-farm	31%
	Both on and off-farm	27%
	On farm	22%
	No diversification	19%

* In cases where percentages do not add up to 100 for each attribute, the respective question was not answered on all questionnaires or is due to rounding

6.3.2. Attitudes to Brexit

Table 6.4 presents the questions relating to Brexit and its impact on farming communities while Figure 6.1 presents the distribution of responses for each Likert scale item for the attitude to Brexit question dataset. High levels of uncertainty surrounding the impact of Brexit on farm businesses and farming communities are reflected in responses to Q.1, Q.4 and Q.5. However, our results also revealed 56% agreeing that Brexit is a challenge that can be overcome, but only 11% think that Brexit will result in fewer regulations and restrictions for farmers. Farmer comments gathered during the survey stress the levels of fear and anxiety felt by some farmers; "We have no idea what Brexit will bring to farming. We are just heading into a dark tunnel." (Tenant, Male, >65, English, Mixed), whilst other, more optimistic views, reinforce the resilience of British farming, "Agriculture is always evolving, and Brexit will bring its own share of change. Farmers are an adaptable and able breed who want nothing more than being accepted for looking after the land and providing food" (Landowner, Male, >65, Scottish, LFA Grazing Livestock).

Table 6.4. Statements on attitudes towards Brexit which respondents answered by a five-point Likert scale (Strongly agree to Strongly disagree).

Number	Statement
Q.1	Brexit will create uncertainty in farming communities
Q.2	Brexit is another challenge to farming that can be overcome
Q.3	Brexit means I need to change my farming practices
Q.4	Brexit will positively impact on wider rural communities
Q.5	Brexit provides an opportunity to improve farm viability
Q.6	Brexit will result in fewer regulations and restrictions for farmers

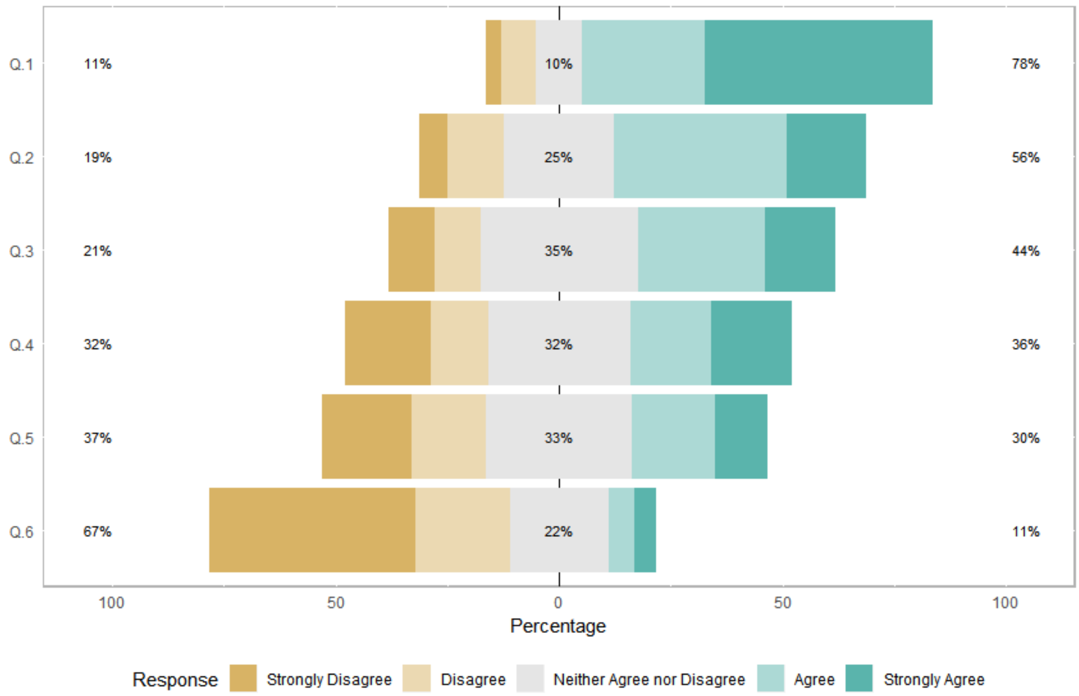


Figure 6.1. Distribution of responses for Likert scales (from strongly disagree, to strongly agree) for attitudinal questions relating to Brexit and its impact on farming communities. Percentages show the totals for strongly disagree and disagree (combined), neither agree nor disagree and strongly agree and agree (combined) (n=204).

Statistical analysis revealed that respondent age had an influencing factor over responses to Q.2, with all farmers age categories <54 years being more likely to agree than those aged >65 ($p<0.03$). In response to Q.3, those who received agricultural education to university level agreed more with the statement than those who gained their agricultural education on farm ($p=0.04$). Those with family members as successors to farm ownership agreed more than those who were unsure of a successor ($p=0.02$). There was no significant difference ($p>0.05$) between demographics in response to any of the other questions or between the summed means.

6.3.3. Attitudes to subsidies

Table 6.5 presents the questions asked in relation to farming subsidies, specifically to the basic payment scheme or 'EU direct payments' (UK Government, 2018). Figure 6.5 presents the distribution of responses for each Likert scale item for the attitude to subsidies dataset. Overall, 68% of respondents agree that current policy on subsidies needs to change but 63% agree that farm viability is reliant on direct payments, with 55% agreeing that farmers should receive public money to ensure continued food production and 43% agreeing that farming subsidies should continue at the current rates. This data also indicated that 50% of farmers agree that the current subsidy system encourages inefficient farming and that subsidies, which instead pay farmers to deliver public goods, give the taxpayer better value for money than direct payment subsidies. In addition, 40% are confident their farm would survive without direct subsidy provision however, regression analysis (Table 6.6) found LFA grazing livestock farms differed from dairy, lowland grazing livestock and other farm types in response to Q.8, with LFA grazing predominantly agreeing that farm viability is reliant on direct subsidies, and the others being predominantly unsure or disagreeing. Only 27% agree that the removal of direct payments would create a more level playing field within UK farming. Comments gathered during the survey show the depth of feeling and the division of feeling towards direct payments: "I believe that subsidies should be abolished and adapt the New Zealand way of thinking. Many farmers would go out of business as a lot of them are lazy farmers and just rely on subsidies." (Landowner, Female, 55 – 64, English, Mixed); "I presently farm profitably without any farm subsidy and look forward to competing on a level playing field with those farmers who presently are only profitable when their subsidy payments are taken into account i.e., subsidies are propping up their unsustainable businesses and contributing to inflated land prices." (Landowner, Male, 45 -54, English, Mixed); "Subsidies should be paid for what the farmers produce, quality meat etc." (Landowner, Male, >65, Welsh, LFA grazing livestock).

*Table 6.5 Statements on attitudes towards farming subsidies, which respondents answered, by a five-point Likert scale (Strongly agree to strongly disagree). Note: 'direct payment subsidies relate to the Basic Payment Scheme. **

Number	Statement
Q.7	Current policy on subsidy provision needs to change
Q.8	Farm viability is reliant on 'direct payment' subsidies
Q.9	A lack of trade deals is a bigger threat than subsidy removal
Q.10	Farmers should receive public money to ensure continued food production
Q.11	Subsidies which pay farmers to deliver public goods give the tax payer better value for money than direct subsidies
Q.12	Farming subsidies encourage inefficient farming
Q.13	Farming subsidies should continue at the current rates
Q.14	I am confident that my farm would survive without 'direct payments' subsidy provision
Q.15	The removal of 'direct payment' subsidies would create a more level playing field within UK farming

* Source: UK Government (2018).

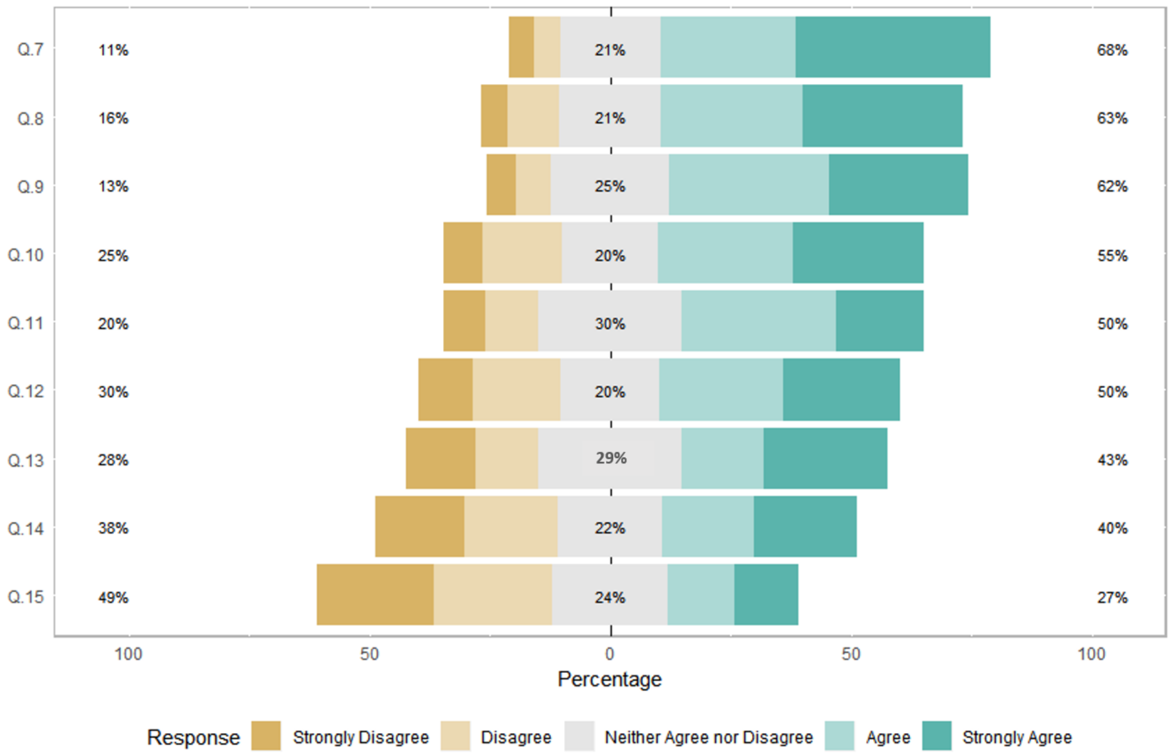


Figure 6.2. Distribution of responses for Likert scales (from strongly disagree, to strongly agree) for attitudinal questions relating to farming subsidies. Percentages show the totals for strongly disagree and disagree (combined), neither agree nor disagree and strongly agree and agree (combined), (n=204).

Table 6.6 shows the questions where regression analysis found significant differences (p<0.05) in response to statements on attitudes between demographic categories.

Table 6.6. The results of a regression analysis showing where there were significant (p<0.05) differences between demographic categories in response to statements on attitudes towards farming subsidies answered by a five-point Likert scale.

Statement	Demographic	Category 1	Category 2	p value
Q.7. Current policy on ‘direct payment’ subsidy provision needs to change	Farm size	21-50 ha	101-200 ha	0.021

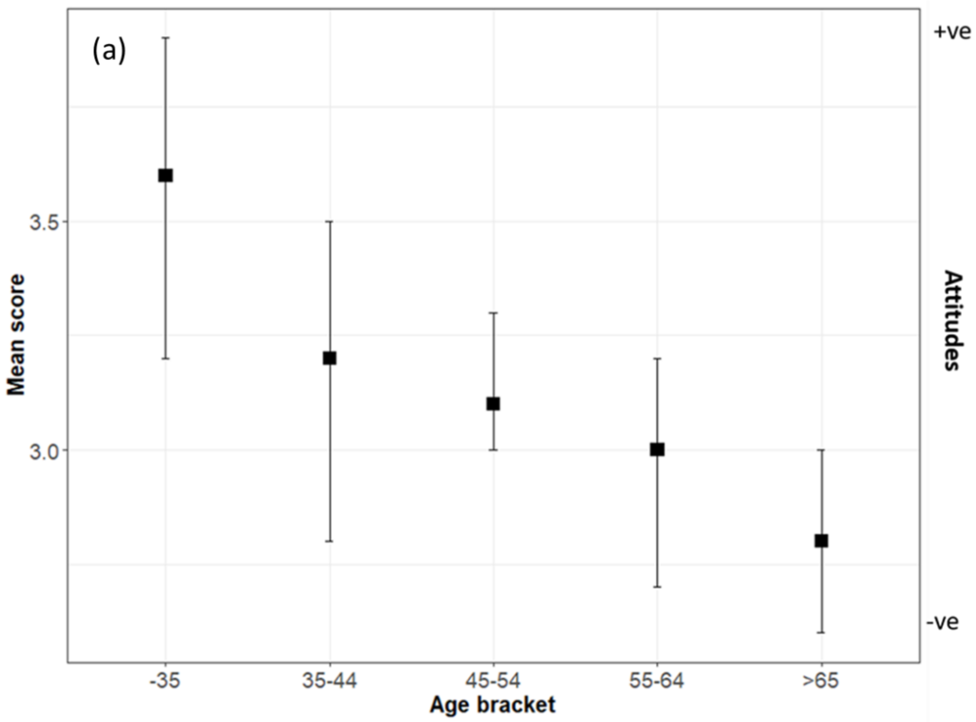
Q.8. Farm viability is reliant on 'direct payment' subsidies	Farm type	LFA grazing livestock	Dairy	0.002
		LFA grazing livestock	Lowland grazing livestock	0.019
		LFA grazing livestock	Other farm types	0.013
	Age	<35	>65	0.02
	AES	Yes	No	<0.001
Q.9. A lack of trade deals is a bigger threat than 'direct payment' subsidy removal	Gender	Male	Female	0.006
Q.10. Farmers should receive public money to ensure continued food production	Farm type	LFA grazing livestock	Other farm types	<0.001

	Age	<35	>65	0.002
		45-54	>65	0.044
Q.12. Farming 'direct payment' subsidies encourage inefficient farming	Age	<35	>65	0.006
Q.14. I am confident that my farm would survive without 'direct payment' subsidy provision	Farm type	LFA grazing livestock	Dairy	0.002
		LFA grazing livestock	Lowland grazing livestock	<0.001
		LFA grazing livestock	Mixed	<0.001
		LFA grazing livestock	Other farm types	0.002

	AES	Yes	No	<0.001
Q.15. The removal of 'direct payment' subsidies would create a more level playing field within UK farming	Farm type	LFA grazing livestock	Dairy	0.003
	Farm Size	<20 ha	51-100 ha	0.04
		<20 ha	101-200 ha	0.005

LFA farmers and farmers aged >65 differed from other farm types and farmers aged <35 and between 45-54 in response to Q.10, with LFA farmers and farmers aged >65, predominantly agreeing they should receive public money to ensure continued food production. LFA farmers are less confident than dairy, lowland grazing livestock, mixed farms and other farm types that their farm would survive without direct subsidy provision (Q.14). Dairy farmers differed from LFA grazing farmers in responses to Q.15, "The removal of direct subsidies would create a more level playing field within UK farming", with LFA farmers predominantly disagreeing and dairy farmers largely agreeing or unsure. Gender only influenced the answer to one question (Q.15), with female farmers thinking that a lack of trade deals poses a greater threat than subsidy removal. Age had an impact on responses to Q.8 where farmer >65 were more inclined to believe that farm viability is reliant on direct subsidies than farmers <35. Farmers aged <35 mainly agreed that farming subsidies encourage inefficient farming, differing significantly in response to farmers aged >65. Farmers participating in AES agree, more than those not, that farming is reliant on farm subsidies. Farmers not in AES are more confident that their farm would survive without direct payment subsidy provision than those in an AES. Further, farmers in AES disagree more than those not that the removal of direct payments would create a more level playing field within UK farming. More 21-50 ha farms agree that farm subsidies need to change than 101-200 ha farms. Small farms (<20 ha) agree more than farms in the 51-100 ha and 101-200 ha categories, that the removal of direct subsidies would create a more level playing field within UK farming.

The means of the summed scores for attitudes towards subsidies identified significant differences between farmers aged <35 and >65 (p=0.011) and between LFA grazing livestock farmers and dairy farmer (p=0.02, Fig. 6.3).



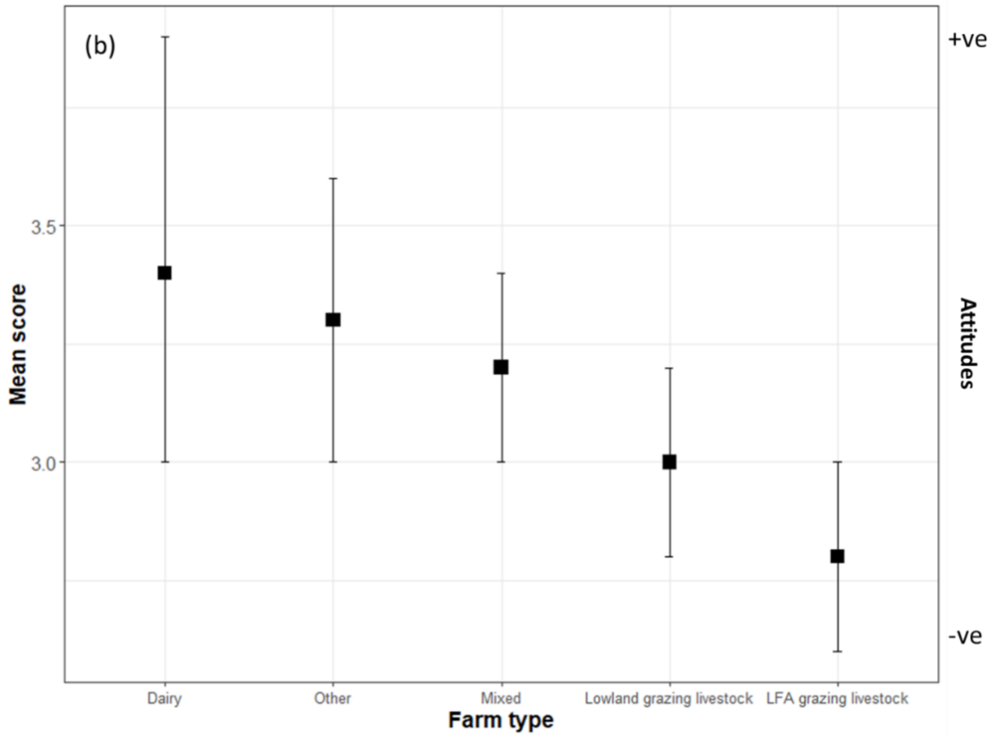


Figure 6.3. Mean of summed scores for age (a) and farm type (b) demographics in response to survey questions 7 -15 on attitudes towards farming subsidies.

An interaction plot (Fig. 6.4) was used to explore differences between respondent age across farm types. There were significant differences in responses across ages and farm types with the most significant difference being between LFA farmers when compared to dairy ($p=0.004$) and mixed farm types ($p=0.048$). This plot shows that LFA farmers have more negative attitudes towards subsidy change than dairy farmers, but it also shows that generally, across all sectors, the older the farmer, the more negative they are towards change.

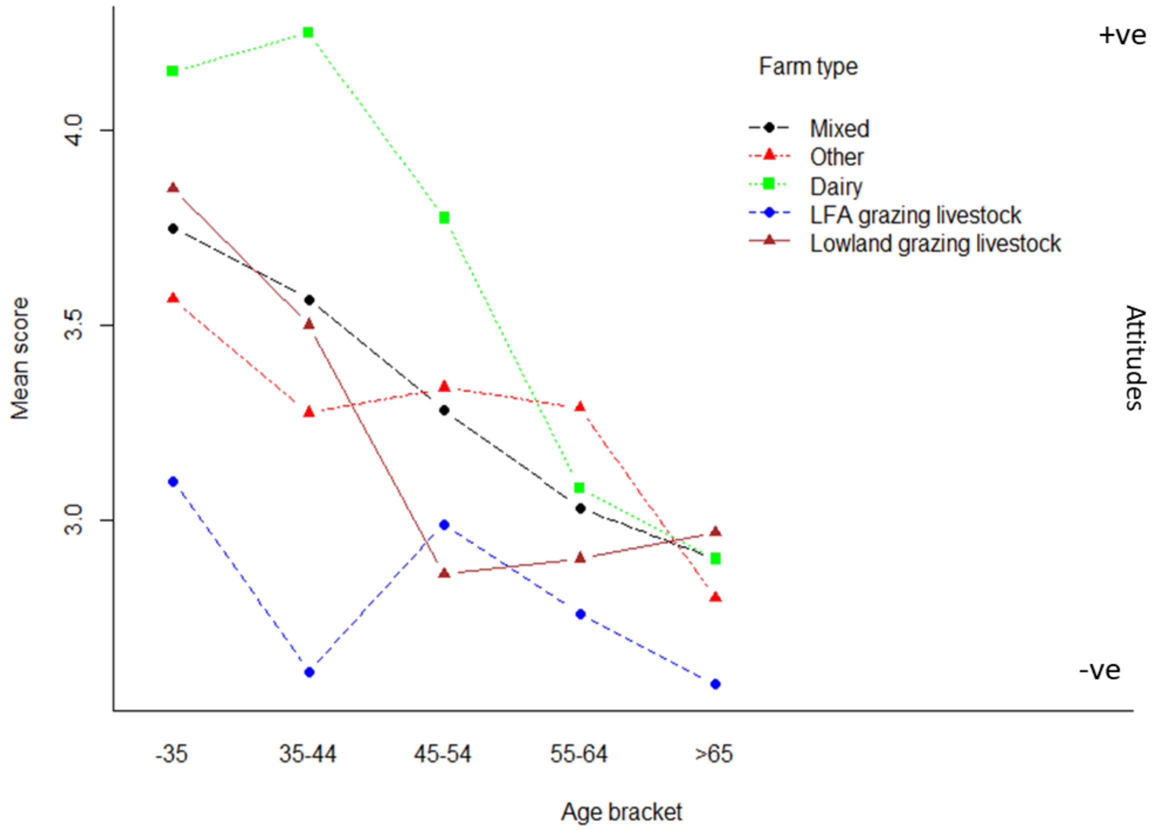


Figure 6.4. Mean scores for farm type and age in response to questions 7 -15 on attitudes towards farming subsidies.

6.3.4. Attitudes to future farming practices

Table 6.7 summarises the questions asked in relation to farming subsidies while Figure 6.5 presents the distribution of responses for each Likert scale item for the attitudes to future farming practices dataset. Our results show 64% being prepared to do whatever is necessary to secure their land for future generations and 58% prepared to change the way they farm. Opinions are split in response to questions 26-31. Forty-six percent agree that they would leave farming if they could not produce food while conversely, forty-four percent agree that they would be prepared to shift from food production to farming for public goods if it ensured farm viability. Forty-four percent agree that food production is more important than farming for public goods but 42% agree that securing land or tenancy is more important than farming for food. Thirty-eight percent would be prepared to reduce food production to deliver public goods but 37% agree that they would increase food production and rely on the market if direct subsidies were removed.

Table 6.7. Statements on attitudes towards future farming practices which respondents answered by a five-point Likert scale (Strongly agree to Strongly disagree).

Number	Statement
Q.23	I would be prepared to collaborate with other farmers to ensure long-term farm viability
Q.24	I would be prepared to do whatever is necessary to secure my land for future generations
Q.25	I would be happy to change the way I farm
Q.26	If I could not produce food, I would leave farming
Q.27	I would be prepared to shift from food production to farming for public goods to ensure farm viability
Q.28	Food production is more important than farming for environmental goods
Q.29	Securing my land/tenancy is more important than farming for food
Q.30	I would be prepared to reduce food production to deliver more environmental goods
Q.31	If direct subsidies were removed, I would increase production and rely on the market

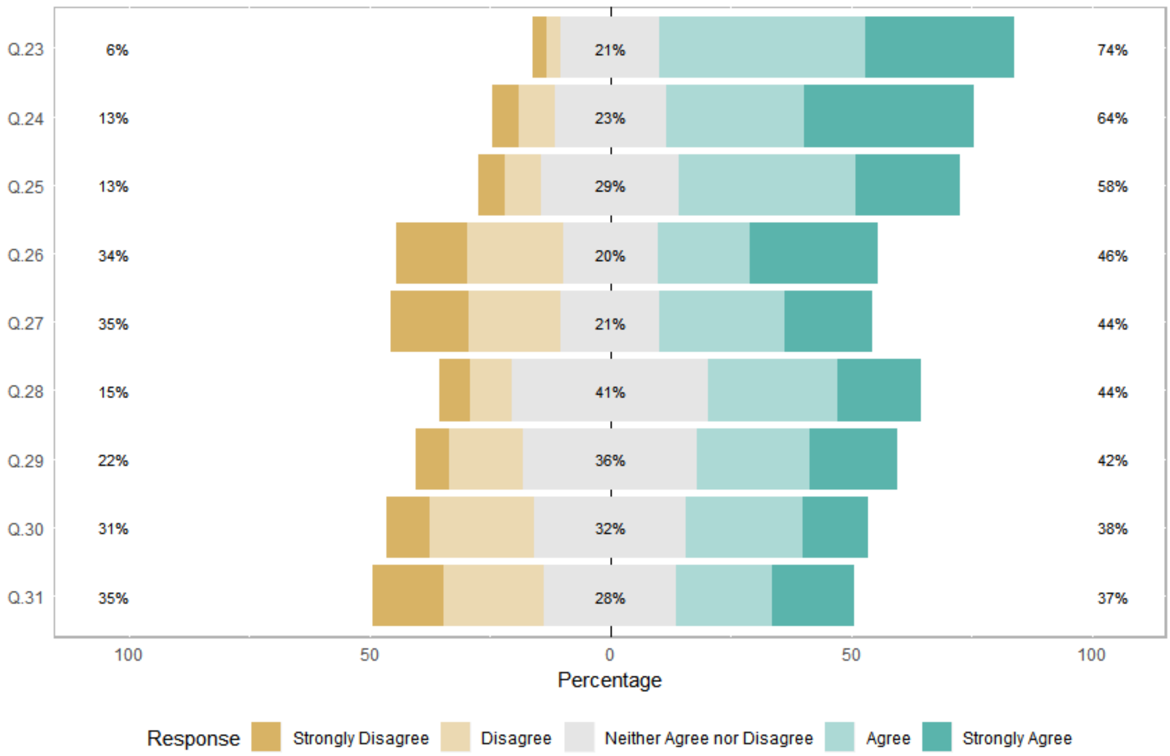


Figure 6.5. Distribution of responses for Likert scales (from strongly disagree, to strongly agree) for attitudinal questions relating to future farming practices. Percentages show the totals for strongly disagree and disagree (combined), neither agree nor disagree and strongly agree and agree (combined).

Table 6.8 shows the questions where there was a significant difference (p<0.05) in response between demographic categories. Large farms in the 51-100 ha and >200 ha categories significantly differed from those <20 ha (p=0.02; p=0.004) in response to Q.24 with the larger farms being more prepared to do what is necessary to ensure farm viability. Larger farms in the 101-200 ha and >200 ha categories are also more likely than the <20 ha farms to increase production and rely on the market (p=0.004 and p=0.002 respectively). Those identifying themselves as businesspersons would be more prepared than food producers to shift from food production to farming for public goods to ensure farm viability (p=0.027). As expected, food producers agree more than land custodians that food production is more important than farming for environmental goods (p=0.03). Farmers aged 45-54 would be more prepared to reduce food production to deliver more environmental goods than those >65 (p=0.023). Participants in AES are more prepared to do whatever is necessary to secure their land for future generations (p=0.024), more willing to change the way they farm (p=0.019) and are more prepared to reduce food production to deliver more environmental goods (p=0.028) than non-participants. Farmers with no diversification income agreed more than those with extensive diversification that they would leave farming if they could not produce food (p=0.016). They are also more likely, than those with off-farm diversification income, to increase production and rely on the market if direct subsidies were removed (p=0.029). Lowland grazing livestock farmers are more likely than other farm types to collaborate with other farmers to ensure farm viability (p=0.016). Farm type (Dairy/lowland grazers, p= 0.026) and ownership (Part owner/tenant-tenant, p=0.026) and succession (2nd generation farmers over 3-5 generation, p= 0.006 and >5 generation, p= 0.015) agreed that securing land/tenancy is more important than farming for food. Further, farmers with a family member successor are more prepared to do whatever is necessary to secure land for future generations than those with no successor (p= <0.001), a non-family member successor (p= 0.048) and those unsure about a successor (p= <0.001). They are also more prepared to reduce food production to deliver more environmental goods than those without a successor (p=0.005). Comments gathered during the survey highlight farmer intentions to follow specific pathways post-policy change; "The probability is that I will sell up in the next few years. I have enjoyed my life as a farmer, and the quality of rural life that I have had. Support for farming over the last 40 years has at times been excessive and misdirected but has given rural communities stability. The focus should always be on food production. Farmers will generally look after the environment and are keen custodians of their farms." (Landowner, Male, >65, English, Dairy); "There is a disconnect between that which is sustainable financially, and that which is sustainable from an environmental and agricultural and possibly social perspective. Financial sustainability will mean 'industrial agriculture'. This is not sustainable environmentally, or from a healthy, vibrant, holistic farm/soil - agricultural perspective, or even socially from the wider general public perspective”, (Landowner, Male, 55 – 64, English, General crops); “I will change from dairy to low output beef (organic)”, (Landowner, Male, >65, English, Dairy).

Table 6.8. The results of a regression analysis showing where there were significant (p<0.05) differences between demographic categories in response to statements on attitudes towards future farming practices answered by a five-point Likert scale.

Statement	Demographic	Category 1	Category 2	p value
Q.23. I would be prepared to collaborate with other farmers to ensure long-term farm viability	Farm type	Lowland grazing livestock	Other farm types	0.016
Q.24. I would be prepared to do whatever is necessary to secure my land for future generations	Farm size	<20 ha	51-100 ha	0.020
		<20 ha	>200 ha	0.004
	Identity	Hobby farmer	Land custodian	0.038
	AES	Yes	No	0.019
	Ownership	Owner/tenant	Tenant	0.026
	Succession	Family member	No successor	<0.001
		Family member	Non-family member	0.048

		Family member	Unsure	<0.001
		No successor	Unsure	0.014
Q.25. I would be happy to change the way I farm	Identity	Smallholder	Land manager	0.047
		Smallholder	Food producer	0.009
		Smallholder	Hobby farmer	0.025
		Smallholder	Businessperson	<0.001
	AES	Yes	No	0.024
	Diversification	Off-farm	On and off-farm	0.013
Q.26. If I could not produce food, I would leave farming	Diversification	No diversification	On and off-farm	0.016
Q.27. I would be prepared to shift from food production to farming for public goods to ensure farm viability	Identity	Food producer	Businessperson	0.027
Q.28. Food production is more important than farming for environmental goods	Identity	Land custodian	Food producer	0.03
Q.29. Securing my land/tenancy is more important than farming for food	Farm type	Dairy	Lowland grazing livestock	0.026
	Time	2nd generation	3-5 generations	0.006

		2nd generation	>5 generations	0.015
	Succession	Family member	No successor	0.005
		No successor	Unsure	0.019
Q.30. I would be prepared to reduce food production to deliver more environmental goods	Age	45-54	>65	0.023
	AES	Yes	No	0.028
Q.31. If direct subsidies were removed, I would increase production and rely on the market	Farm size	<20 ha	101-200 ha	0.004
		<20 ha	>200 ha	0.002

The means of summed scores for attitudes towards future farming practices identified significant differences between farmers participating in AES and those not (p=0.004, Fig. 6.8) but no significant differences in between summed scores across all the other demographics.

6.4. Discussion

6.4.1. Attitudes to Brexit

The results presented here show a high level of uncertainty over the future of farming post-Brexit. Despite this uncertainty, pre- and post-referendum surveys, show farmers having a preference to leave the EU but this varies slightly between surveys (Farmers Weekly, 2016;

NFU, 2016; The Scottish Farmer, 2016; Farmers Weekly, 2017; BBC, 2018; Martin, 2018; NFU, 2018). Values and goals affect and may be affected by decision-making (Öhlmér et al., 1998) and are important in understanding the decisions made by farmers (Willock et al., 1999). In the case of the EU referendum, farmers voted based on the same concerns as the public in general, rather than agricultural policy. Some studies show 'leavers' were concerned about EU regulatory restrictions and issues such as loss of sovereignty and migration whilst 'remainers' were more concerned about market access and loss of support (Grant, 2016b). However, this survey shows only 11% of respondents agreeing that an EU exit would result in fewer regulations and restrictions compared to 67% who believed it would not. The 56% of our respondents agreeing that the challenges of Brexit can be overcome are potentially reflective of the 53% stating they voted to leave the EU (Farmers Weekly, 2017). An exit from the EU may bring elements of economic, social and environmental uncertainty but farmers have always had to cope with uncertainty, especially regarding weather patterns, prices and policy change (Urry, 2005; Franks, 2006; Darnhofer et al., 2010; Darnhofer et al., 2016). This belief that they are able to evolve and adapt to change, shows a level of resilience that will enable many farmers to respond to new challenges as they arise (Darnhofer et al., 2010; Darnhofer et al., 2016).

Farmers with a successor agreed more than those without that they would have to change farming practice. Some farmers see the capital asset provided by land ownership, and the succession of that land to family members, as being the key to the resilience of farm businesses (Pomeroy, 2015). Older farmers without a successor tend to be less productive, less open to engage in environmental practices and more likely to continue farming at low intensity (Duesberg et al., 2017). Succession, which gives an opportunity for business practices to be learned over time, forms a logical moment for the farm family to reflect on and adjust farming practices and therefore directly effects on farm performance (Inwood and Sharp, 2012). This survey shows that farmers <54 believe the challenges of Brexit can be overcome therefore, a change in ownership to younger, forward thinking, farmers may bring bringing innovation, entrepreneurship and new ideas into agriculture (Baker et al., 2016). The findings, discussed in the next section, find significant differences between demographics in response to questions relating to direct subsidy provision and the impact of their removal.

6.4.2. *Attitudes to subsidies and public goods delivery*

During the forty-five years since the UK joined the CAP, its reform development processes have led to a confusing muddle of policy instruments (Medina and Potter, 2017). Direct subsidy payments are seen to benefit those who own the land, dominated by larger, more intensive farms, over poorer and marginal farmers, who, due to constraints of land and weather, are not very efficient in terms of food outputs and are therefore sustained by the area-based payments (Helm, 2017). This makes the CAP one of the least-respected of EU policies (Packer, 2017). Policy change, likely to impact on this subsidy provision, will emerge because of a UK exit from the EU (Defra, 2018; House of Commons Northern Ireland Affairs Committee, 2018; SG, 2018; WG, 2018). It is currently estimated that EU subsidies make up between 50 to 60% of farm income in the UK though this varies between countries (Häberli, 2017) and around average income estimates between farms (Daera, 2017ab; Defra, 2017ab; SG, 2017ab: WG, 2017ab). However, not all farmers support or rely on the current subsidy support system with many believing it to be inefficient (50% of our respondent believe direct subsidy payments support inefficiency in farming).

Urdiales et al. (2016) found the age of the farmer has a negative impact on ecological efficiency of the farm. This result is in line with Reinhard et al. (2002) who found younger farmers more likely to be knowledgeable about environmentally friendly technological progress. Previous studies show direct subsidy payments negatively affecting farmers' effort and their technical efficiency (Gailhard and Bojnec, 2015; Minviel and Latruffe, 2017), also showing farmers have fewer incentives to efficiently work the land when they receive government subsidies (Serra et al., 2008). This study supports these findings showing young farmers <35 more likely than those >65 to believe that direct subsidies encourage inefficiencies. Whilst a move away from direct payment subsidies may be seen by many, mainly LFA grazers and farmers aged >65, as being contentious, the negative perceptions of subsidy support, especially amongst younger farmers, add levels of legitimacy and acceptance, acting as an enabler of future policy change.

The steep slopes, altitude and high rainfall levels, that make LFA grazing a less profitable income source (Wales Rural Observatory, 2011) make them the most likely to be impacted by changes to the subsidy system (Grant, 2016a; Dwyer, 2018), but these habitats also create financial opportunities through the availability of agri-environmental public goods (Jones et al., 2015; Arnott et al., 2019). This study shows LFA graziers to be highly aware of the potential financial challenges that will arise from a policy change that removes direct payment subsidies. However, it also highlights a willingness to adapt and change, to embrace public goods delivery and do what is necessary to secure the farm and the land. Awareness of these attitudes to adaptation will support policy-makers in their desire to gain acceptance for a policy aimed at attaining climate change targets and support farming communities, through the provision of public money for the delivery of public goods (Defra, 2018; House of Commons Northern Ireland Affairs Committee, 2018; SG, 2018; WG, 2018). These proposals, made across UK administrations (Defra, 2018; House of Commons Northern Ireland Affairs Committee, 2018; SG, 2018; WG, 2018), to shift agricultural subsidy provision to a public money for public goods approach presents an opportunity for a true win-win situation which can benefit the natural environment, tax payers and wider society, and the farming community itself (Bateman and Balmford, 2018). Policymakers must, however take into account factors that have previously hindered the adoption of policy instruments. In this survey, the majority of respondents were confident that they could deliver public goods, but with only 59% of respondents to our survey, stating they understood what is meant by 'public goods' the question of understanding must be raised. A lack of awareness or knowledge linked with the wide diversity of ecosystem services has previously posed a barrier to AES participation (Page and Bellotti, 2015). A confidence in an ability to deliver, and an understanding of the negative impact of ecosystem services loss does not necessarily translate into actual delivery (Smith and Sullivan, 2014). A perceived lack of ability to manage multiple ecosystem services (Smith and Sullivan, 2014), the 'interference of others' and fear of a loss of control may also translate into to a reluctance to join AES (Wynne-Jones, 2013; Riley, 2016). For some AES participants, initial engagement can be classified as 'opportunist', based not on environmental orientations, but on the goodness of fit to existing farming practices (Riley, 2016; Arnott et al., 2019), the importance of financial imperatives (Lastra-Bravo et al., 2015), and the influence of factors such as farm size, tenure, or farm type (Wilson and Hart, 2000; Lastra-Bravo et al., 2015). An opportunist approach, and participation in AES, may not necessarily change farmers' attitudes towards conservation (Wilson and Hart, 2001). The results of this study show participation in AES and farm type, namely LFA grazing over dairy, to be significant factors in positive approaches towards public goods delivery but this does not necessarily indicate a change in attitudes towards conservation. It may instead be a strategy employed to increase farm resilience, not all farmers are opportunist, many are forward thinking embracing AES and incorporating environmental practices into holistic land management plans proving that AES can influence and change behaviour (Riley, 2016).

6.4.3. Attitudes to future farming practices

Previous studies by Giannoccaro and Berbel (2013) and Latruffe et al. (2013) found the removal of the CAP would not, for most respondents, result in any change in exit and farming intentions, rather it may reinforce many existing trends, namely towards decreasing chemical use and more sustainable water use. This study shows 46% agreeing that they would consider leaving farming if they could not produce food, a significant increase on the 21% of Latruffe et al. (2013) and the 20-27% of the WRO (2010; 2013). The relatively high intention to exit farming, if food production was not a priority, found here may be a reaction to government intentions to move to greener agricultural systems (Gove, 2018) as the connection between the farmer and the production-oriented approach to agriculture goes far deeper than simple economic advantage or aesthetic preference (Burton, 2004; Wynne-Jones, 2013; Wynne-Jones, 2017). To date, CAP reforms have seen a shift from subsidies coupled to production to a decoupled system where farmers are paid for the agricultural land they manage and for the delivery of AES options. Post-Brexit policy will attempt to drive farmers towards new 'post-productivist' roles which in many cases will be far removed from the deeply engrained cultural concept of the 'good farmer', namely one where farmers see themselves first and foremost as food producers (Burton, 2004). Demographic responses show 22% of respondent identifying themselves as food producers. Food production gives farmers their identity and their sense of achievement. It can make them more likely to resist change or, if changes are implemented too quickly and they see no benefits of continuing in agriculture, many may not adapt but may simply choose to leave agriculture (Burton, 2004). As part of the post-Brexit exit strategy the Agriculture Bill 2019-20 (UK Parliament, 2020), has introduced the facility for farmers to use direct payments as an incentive to retire from the industry. These incentives may present older farmers with an alternative retirement plan, avoiding a gradual wind down and potentially freeing up agricultural land allowing younger farmers to enter the market, but in reality, they are not guaranteed to work (Briggs, 2021). Often farmers, especially where no successor can be designated, will gradually wind down their business rather than selling up or leasing the land out to younger farmers outside the family, potentially creating food security and rural depopulation issues (Duesberg et al., 2017). Family farms, with successors, are significantly more prepared than those with non-family members or without successors to do whatever is necessary to secure the land for future generations. They will often pursue innovative strategies, including being prepared to move out of food production (p=0.005), in order to tackle challenges caused by rapidly changing environments and to safeguard the long-term survival of the farm (Suess-Reyes and Fuetsch, 2016).

In additional, and perhaps unsurprisingly, AES participants are found to be significantly more positive in their attitudes towards diversification of future farming practices into a public goods approach than those currently not participating. The direction in which future farming practices will take, while influenced by age, participation in AES and farm type, will also be driven by market demand and future trade deals. Change is inevitable, and whilst a few may look to increase production or change farming practice to meet market demands, we show that a willingness to embrace a move towards public goods delivery is present across most sectors and demographics. Payments which incentivise retirement from the industry, introduced in the Agriculture Bill 2017-2019 (UK Parliament. 2018), may offer alternatives to those most resistant to change and create opportunities for younger, more innovative farmers to enter the industry.

6.5. Conclusions

In conclusion, potential policy change, especially the proposed removal of subsidies, is shown to create uncertainty within the farming sector, but a large percentage of respondents believe that change is necessary and would be willing to embrace public goods delivery in order to ensure farm viability. The current subsidy system is seen as being unfair and whilst the majority of respondents agree it needs to change, LFA grazing and mixed livestock farmers, more reliant on subsidies, are less confident that they would survive if they were removed. This category of farmer is undoubtedly, the most economically vulnerable when faced with a policy change which removes direct payment subsidies. However, they are also the category of farmer arguably best positioned to join schemes making payments for public goods. If transaction and administration costs are reduced, making schemes more accessible to farmers, this could create a win-win situation for both farmer and policymaker.

Conversely, dairy and small-scale farmers believe that the removal of subsidies would create a level playing field and younger farmers believe they create inefficiency. Younger farmers, those currently participating in AES and LFA grazing farmers are more positive towards public goods delivery whilst farms with a successor would be willing to do what is necessary to secure their farm for future generations. Age and farm size are linked to a productivist attitude with larger farms, and farmers aged <65, being more resistant to change. Here it is shown that policy change brings uncertainty but farmers are used to uncertainty and challenges arising from weather, price and policy change are relatively commonplace. There is resilience in agriculture, the farming community adapts to challenges and employ coping strategies that ensure farm survivability. A UK exit from the EU will bring with it its own set of challenges that are likely to see a shift in the way land management is conducted in the UK. Whilst some ‘productivists’ may be reluctant to change, there is no doubt that, with a EU exit, a change towards a greener, more sustainable, agricultural landscape is coming. There is a desire for change to the current subsidy system. Therefore, a move towards a ‘public money for public goods’ presents an opportunity to develop schemes, which farmers would be willing to adopt, that creates a ‘win-win’ situation where the most vulnerable are supported, environmental goods and services are delivered and young farmers are encouraged to take the UK’s agricultural industry into a sustainable future.

Acknowledgements

Thanks go to the Welsh Government's Agricultural Statistics Office for their assistance in stratification planning and with farmer contact details. The FLEXIS (Flexible Integrated Energy Systems) programme funded through the Welsh European Funding Office (WEFO) supported this work

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Chapter 7

Importance of building bridging and linking social capital in adapting to changes in agricultural policy

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This manuscript is published in the Journal of Rural Studies

D.A. designed and conceived the research. D.A. conducted the analysis of the data and prepared the manuscript. All authors discussed results and contributed to preparation of the manuscript.

7.1. Introduction

The UK government is responding to overwhelming evidence that greenhouse gases (GHG) are driving global climate change by pledging to reach net zero GHG emissions by 2050 (CCC, 2019; Skidmore, 2019.). Achieving this target will require changes to farming and land use putting more emphasis on carbon sequestration and biomass production (CCC, 2019). In future, farmers will no longer receive Basic Payment Scheme (BPS) support, which pays per hectare of agricultural land if cross compliance rules, which state they must keep land in a good agricultural and environmental condition, are adhered to (Rural Payments Agency, 2019). Instead, farmers wishing to receive financial support will have to embrace sustainable land management (SLM) practices which support government targets (Defra, 2018; Welsh Government, 2019). Change is inevitable and farmers must decide whether to adopt or reject SLM practices.

The innovation-decision process (Rogers, 2010) identifies five stages that an individual must go through before adopting or rejecting a new idea. 1. Knowledge – the individual is exposed to the idea and how it is going to work. 2. Persuasion – the individual forms a favourable or unfavourable opinion of the idea. 3. Decision – the individual decides to adopt or reject the idea. 4. Implementation – the individual puts the idea into practice. 5. Confirmation – the individual seeks reinforcement of their decision. In all these stages an individual's network links are important determinants in their adoption of new ideas (Rogers, 2010). Decision-makers are influenced by people for whom they have respect or who are important to them (Broers et al. 2019; Cofré-Bravo et al., 2019). Social capital is defined by Putman (1995) as the characteristics of social organisation, such as social networks, norms and social trust, which foster coordination and cooperation among community members. Cultural capital is the accumulation of knowledge, behaviours, and skills that a person can tap into to demonstrate one's cultural competence and social status (Bourdieu, 1977). Social and cultural capital are increasingly acknowledged to be of critical importance in farmers' decision-making (Mathijs, 2003; Burton et al., 2008; Hunecke et al., 2017; Cofré-Bravo et al., 2019). Social capital can be further categorised as, i. bonding (exclusive) social capital which focuses on ties of solidarity between similar groups of people (Heenan, 2010), ii. bridging (inclusive) social capital which refers to horizontal trust and reciprocal connections between diverse individuals such as between farmers and others (de Krom, 2017; Heenan, 2010), and iii. linking social capital which creates forms of power and influence in community interactions (Woolcock, 2001; Stanton-Salazar, 2004) and enables access to resources, ideas and information from formal institutions beyond the community (Pretty, 2003). An understanding of social capital levels within farming communities helps policymakers understand how farmers access information, who are the influencing factors in the decision-making process and what networks give access to the knowledge and resources that farmers need to adapt. If farmers are to achieve change in long-term pro-environmental behaviours, they need to build the 'bridging social capital' that will give them access to new knowledge (Cofré-Bravo et al., 2019) and gain them appreciation from stakeholders out-with agricultural networks (de Krom, 2017; Polman and Slangen, 2008).

7.1.1. Social capital and the farming community

Without social capital, many aspects of social life that involve co-ordination between or within social groups will be greatly impoverished (Burton et al., 2005). Communities endowed with a rich stock of social networks and civic associations are likely to be in a stronger position to deal with crisis, tensions and challenges to the community, such as those arising from agricultural policy change (Diaz and Nelson, 2005). Historically, communal farm tasks such as hay/silage making, sheep shearing and livestock fell gathering where farmers came together as a community, provided an opportunity for the generation of social capital (Burton et al., 2005). However, recent developments in agriculture have witnessed the decline of co-operative working practices, a decrease in time available for co-operation, and the continuing decline in the number of upland farmers (Burton et al., 2005; Heenan, 2010). This in turn leads to decline in the overall levels of social capital in farming communities (Burton et al., 2005). Strong levels of bonding capital created through agricultural related activities, fosters knowledge exchange, creates lobby groups and gives access to new markets and ideas (Burton et al., 2005). However, strong levels of bonding capital often found within tight knit communities can also reduce the flow of new ideas into the group. This can result in parochialism and inertia which can create resistance to both compromise and change (Gargiulo and Bernassi, 1999; Flora, 2004). Bridging social capital is arguably more valuable than bonding social capital when adapting to change (Monteil et al., 2020). It allows different groups to share and exchange information, ideas and innovation and builds consensus among the groups representing diverse interests (Claridge, 2018). It has the potential to generate widespread benefits such as increased cooperation, appreciation and social ties with other regional stakeholders (de Krom, 2017; Abenakyo et al., 2007; Pretty, 2003; Putnam, 2000). However, like bonding capital there can also be a negative consequence to achieving bridging capital. Communities or individuals seeking to expand their social networks may find bridging capital comes at the expense of groups they were once able to call upon for bonding capital (Leonard, 2004). Whereas bonding and bridging social capital refer to 'horizontal' social networks and relationships, linking social capital reflects how communities are 'vertically' networked with institutions and political structures (Warren et al., 2001; Szreter and Woolcock, 2004). Hall and Pretty (2008) found farmers with higher linking social capital progressing more in their personal transition to SLM practices than farmers with low linking social capital who felt disempowered and averse to contact with government agency staff. The organization of society itself, reflects historical, cultural, social, political, and economic processes (Greif, 1994). Therefore, relations within and between social groups at different levels of society shape the prospects for sustainable, equitable growth and just participatory governance (Woolcock, 1998). A lack of social capital may lead to a limited uptake of sustainable management practices. Where this is the case, strategies to address this would benefit from incorporating measures focused on building bridging and linking social capital, as well as trust between stakeholders (Rust et al., 2020). This paper aims to contribute to current literature on the importance of social capital in adapting to policy change through a study of UK farmers across differing locations and categories. It aims to identify levels and type of social capital being accessed by farmers in order to ascertain how levels of social capital may hinder or enhance a farmer's willingness to adapt.

7.2. Methodology

7.2.1. Sample and questionnaire

Agriculture in the uplands (altitudes >300 m above sea level) of England and Wales is usually less intensive than in the lowlands with many upland grassland areas situated within National Parks or Areas of Outstanding Natural Beauty (Hopkins and Wainwright, 1989). This study gained its sample through the snowball sampling technique. This is a strategy often utilized to overcome the problems associated with understanding and sampling populations which are difficult for researchers to access (Atkinson and Flint, 2004). The study uses a sample from a cross-section of upland farmers in, and on the boundaries of, the Yorkshire Dales and North York Moors National parks in England and the Snowdonia National Parks in Wales. In England, contact was made with the Yorkshire Dales and North York Moors National Park Farming Officers and in Wales with the Aber and Llanfairfechan grazing association, the Henfaes Research Centre and the National Trust. These organisations contacted farmers within their network and farmers who responded were asked to identify other farmers who could be contacted and who may be willing to participate. Thirty-seven farmers agreed to participate in the survey. However, one did not appear at the arranged time and further attempts to rearrange the interview failed and two of the recorded interviews were inaudible due to external noise interference. The study focuses on upland farmers but across all farming areas there are farmers that farm in an extensive, nature-friendly way whilst others have a more conventional production focus. Three categories of farmers were chosen to reflect these differences and to determine if levels and types of social capital also differ between farming approaches,

- Those not in AES –farmers with a conventional production-focused approach. A move towards a ‘public goods’ approach would represent a significant change in farming practice.
- Those in AES – farmers who participate in state-run AES delivering only the prescriptions required of the scheme.
- The HNVF group –farmers who participate in state-run AES but also adopt farming practices which deliver environmental benefits above that required of the AES prescriptions.

Grootaert and Van Bastelar (2002) suggest a tool that integrates both quantitative and qualitative methods when measuring social capital is likely to be more useful and reliable than measures based on only one type of research methodology. As this research aims to gain an in-depth understanding of social capital levels across both the structural (relating to networks, roles, rules and precedents) and cognitive (relating to norms, values, attitudes, and beliefs) elements of social capital, both quantitative and qualitative methods were employed. Interviews were conducted on farm, using semi-structured questionnaires based on the six dimensions of social capital used by the World Bank to measure social capital (Grootaert et al., 2004), viz; Groups and Networks, Trust and Solidarity, Collective Action and Cooperation, Information and Communication, Social Cohesion and Inclusion, Empowerment and Political Action (SI 1). The World Bank’s “Integrated Questionnaires for Measurement of Social Capital” (SC-IQ; Grootaert et al., 2004), which aims to strike a balance between conceptual rigor and cross-cultural flexibility and adaptability, provided a question framework which was adapted to the local settings. The average recorded interview time was 45 min but prior to the start of the recorded interview ~20-30 min was spent explaining the reasons for the interview, what was being studied, how the data would be used and participants were reassured as to their anonymity. In most cases this was done in a very informal and relaxed way but in the shorter interviews the farmer was keen to get started and move the process on as quickly as possible.

Qualitative data collection enabled us to explore the nature and extent of the farmer's participation in various types of social organizations and informal networks whilst the qualitative approach enabled the researchers to uncover subjective meanings and interpretations in a way that would be impossible with quantitative approaches (Tracy, 2019). Interview questions, adapted from the SC-IQ, retained some of the quantitative Likert questions found in the SC-IQ for categories other than groups but, because of the sample size and the qualitative nature of the interview, these were used to stimulate thought and further discussion and no statistical analysis was completed on these results. Multiple choice questions were used to gather demographics data and open questions were used to gather data on AES participation and diversification activities.

7.2.2. Analysis

Interviews were digitally recorded, fully transcribed and analysed using thematic analysis techniques which is a method of "identifying, analysing, and reporting patterns (themes) within data (Castleberry and Nolen, 2018). Analysis was performed through a process of (i) reading and familiarization with the interview transcripts and (ii) compiling and organizing the data across the six dimensions of social capital, used by the World Bank to measure social capital, and which formed the structure of the question set (Castleberry and Nolen, 2018). Open coding (Goulding, 1999; Moghaddam, 2006) was used to (a) to explore how individuals interact within the community and how perceptions of community have changed over time and (b) identify differences between groups in the type and levels of social capital within the six dimensions of social capital identified by the World Bank.

To increase the reliability and validity of the process the same researcher undertook all the fieldwork on an individual basis with the farmer. Researcher effects were reduced by conducting the interviews in the farmer's home at a pace dictated by the farmer. Several tactics were employed to test and confirm findings (Hubberman and Miles, 1994). On completion of the analysis three participants were revisited to discuss and review the findings. All revisited participants agreed with the findings. The analysis was further peer-reviewed and verified by the contributors to the paper, who read through the findings making additional comments where necessary. These areas were reviewed and amended prior to submission. There are some limitations to the survey. In the sample breakdown the number of non-AES participants is smaller than the other groups mainly due to higher percentages of upland farmers participating in AES than in other areas. Participants also live and work in or on the boundaries of national parks and this could potentially influence views of community as levels of incomers may be higher in national parks. Future research would be useful to confirm the findings of these results in other farming communities.

7.3. Results

7.3.1. Demographics

Table 7.1 shows the demographic breakdown for the thirty-four study participants with viable transcripts.

Table 7.1: Demographics for study participants in the North York Moors (NYM), Yorkshire Dales National Park (YDNP) and North Wales (NW) by category - agri-environment scheme (AES), no agri-environment scheme (Non-AES) and high nature value farming (HNVF).

Category	Location	Farm type	Gender	Age	Type of AES	Diversification

AES	NYM	LFA Livestock	Male	60	ESS Entry/HLS	None
		LFA Livestock	Female	54	ESS HLS/Commons	None
		Mixed	Male	57	ESS/HLS	Contracting
		LFA Livestock	Male	54	ESS Entry/HLS	Riding stables
		LFA Livestock	Male	N/K	ESS Entry/HLS	None
		Arable	Male	82	ESS/Entry	Rentals
	YDNP	LFA Livestock	Male	N/K	YDNP Pilot Scheme	None
		LFA Livestock	Female	N/K	YDNP Pilot Scheme	Off farm work
		LFA Livestock	Male	57	CSS Higher level	None
		Dairy	Male	54	Capital Works	Solar panels
		LFA Livestock	Male	64	ESS/HLS	None
	NW	LFA Livestock	Male	70	Glastir Advanced	Rentals
Non-AES	NYM	Dairy	Male	65	None	AirBnb
		Mixed	Male	48	None	B&B
		LFA Livestock	Male	58	None	Off farm work
	YDNP	LFA Livestock	Male	59	None	Rentals
		Dairy	Male	29	None	Contracting
		LFA Livestock	Male	47	None	None
	NW	LFA Livestock	Male	50	None	Rentals
		LFA Livestock	Male	51	None	Off farm work
		Lowland cattle	Male	22	None	Kennels
HNVF	NYM	LFA Livestock	Female	57	ESS Entry/HLS	Off farm work
		Mixed	Female	65	CSS Higher level	Off farm work
		LFA Livestock	Male	83	ESS Entry/HLS	Off farm work
		Grassland	Male	50	NP Scheme	Off farm work
		Grassland/woodland	Male	79	ESS Entry	Off farm work
	YDNP	LFA Livestock	Male	65	CSS Higher level	Weddings
		LFA Livestock	Male	61	ESS HLS	Off farm work
		LFA Livestock	Male	50	CSS Higher level	Rentals
		Lowland Livestock	Male	66	ESS/HLS	None
	NW	LFA Livestock	Male	N/K	Glastir Advanced	Off farm work
		LFA Livestock	Female	25	None	None

LFA Livestock	Male	34	Glastir Advanced	None
LFA Livestock	Male	31	Glastir Advanced	School taxis

7.3.2. Groups and networks

This is the category most associated with social capital (Grootaert et al., 2004). The study considers the nature and extent of the farmer's participation in various types of social organizations and informal networks, and the range of contributions that the individual, within the different farmer categories, gives and receives from them. The quantitative data enabled participant groups to be clustered by type and importance. Social groups in which interviewees participate, or are members of, were grouped by type into four categories (Appendix 3, fig. S1);

(i) Agricultural/land-based groups: Work related groups directly related to production

(ii) Non-agricultural/environmental groups. Work related groups, non-production related.

(iii) Political/community groups. Groups that can enable members to influence or change policy at community and national levels.

and

(iv) Social/church groups. Non-work-related groups which are accessed for social interaction or leisure.

A useful classification to determine levels of social capital is the scope of the group: whether groups operate only in the community or are affiliated with other groups (inside or outside the community; Grootaert et al., 2004). Table 7.2 shows the mean number of groups (total and important per farmer in each farmer category and a summary of group demographics in each of the group categories).

7.3.3. Non-AES category

Farmers in the non-AES category participate in agricultural/land-based groups (n=27) more than either the AES (n=24) or HNVF groups (n=17; Table 7.2). They find groups such as breed associations, farmers' unions, farmer networks, grazing associations, trade support groups and young farmer groups, more important than other group categories. Age, gender and education levels vary between members but these groups mainly consist of people within the farming community. Members of these groups frequently interact with people with similar interests to them but they rarely interact or access information from people with other interests. The non-AES farmers have the lowest participatory rates in non-agricultural/environmental groups (n=1) and find them the least important.

Only two of the non-AES farmers actively participate in political/community groups compared to five in both the AES and HNVF groups. Fifty percent of the non-AES farmers participate in social/church groups compared to 38% of AES and 54% of the HNVF groups. Participants from this group have on average 3-5 close friends and have people they could turn to for help if they had a short- or long-term emergency term. Three of the farmers say they seek advice or discuss farming issues with other farmers on a weekly basis but for the others it is monthly or less. Advice seeking outside of the immediate network is rare but when it happens it tends to be with organisations such as Defra and the RPA. Participants often join these groups for personal gain or protection rather than social interaction e.g., farmers may have to be members of a breed association to sell livestock in certain markets or will join the NFU for protection and advice.

"I'm only in the mule association so I can sell my gimmer lambs and that's the only reason why and I don't go to no meetings or anything", (YDNP 1, AES).

Members of these groups can benefit socially and professionally from knowledge exchange and interaction with other farmers and advisors.

"The agricultural society show has made a lot of difference to my contacts within the farming community. It takes a great amount of time, it is a great way of integrating us, as we have recently moved into the area and come into the community", (NYM 9, Non-AES).

The strong ties of solidarity and levels of interaction between farmers in the non-AES group show access to high levels of bonding social capital which can help foster knowledge exchange, create lobby groups and give access to new markets and ideas. However low levels of interaction with people or groups outside of the farming sector, especially with non-agricultural and environmental groups indicate low levels of bridging social capital. This combined with low levels of linking social capital, which empowers individuals and gives them access to resources, may hinder the farmers in the non-AES when adapting to future agricultural policy change and a move towards a 'public money for public goods' approach to farming support.

7.3.4. AES category

Farmers in the AES category have a lower average agricultural/land-based group membership (1.8/farmer) that the non-AES (2.7/farmer) but they place the same level of importance on them as the non-AES group. Forty-two percent of the farmers in this category are members of non-agricultural/environmental groups compared to 1% of the non-AES and 85% of the HNVF group however, they do not rank these groups as important. On average, the farmers in this group state they have more than five close friends and that they have people they could turn to if they had short- or long-term emergencies. However, they would turn to family first with 50% of them stating they could not count on their neighbours. Four of the five farmers who participate in political/community groups are members of village councils, with one being in a parish council, and feel they are contributing to the community.

Table 7.2. Mean number of groups (total and important per farmer in each category and a summary of demographics in each of the groups and social capital type.

		Agricultural/land-based Groups			Non-agricultural/environmental groups			Political/community groups			Social/church groups		
	Farmer category	Total groups	Range	Important groups	Total groups	Range	Important groups	Total groups	Range	Important groups	Total groups	Range	Important groups
Mean number of groups per farmer in each category	Non-AES	n=27/2.7	0-5	1.1	n=1/0.1	0-1	0.0	n=4/0.4	0-3	0.2	n=6/0.6	0-1	0.2
	AES	n=24/1.8	0-5	1.1	n=9/0.7	0-3	0.1	n=5/0.4	0-1	0.3	n=8/0.6	0-2	0.3
	HNVF	n=17/1.3	0-4	0.5	n=21/1.6	0-5	0.7	n=12/0.9	0-3	0.3	n=15/1.2	0-4	0.3
Group demographics	Similar occupation	Yes			No			No			No		
	Same gender	No			No			No			No		
	Same age group	No			No			No			No		
	Similar education	No/not known			No			No			No		
	Locality of members	Mixed locations/local			Mixed locations			Mixed locations			Local		
	Familiarity with members	Familiar and new introductions			Familiar and new introductions			Familiar and new introductions			Familiar		
	Method of joining	Applied/invited			Invited/elected			Applied/word of mouth			Informal/invited		
	Membership Status	Stable to declining			Stable to increasing			Unsure			Unsure		
	Interaction with similar groups	Frequent			Frequent			Frequent			Frequent		
	Interaction with different groups	Rarely			Frequent			Frequent			Rarely		
	Group funding	Subscriptions/government			Government/self-funded			Subscription/self-funding			Self-funded		
	Group founder	Community leaders/government			Community leaders/government/NGO			Community leaders			Community leaders		
	Social capital type	Bonding			Bridging			Linking			Bonding/bridging		

"The main benefit that I think that I can bring is the fact that I'm a local, a lot of parish councils now are, not so much in Helmsley, but certainly in the different areas, through talking with different people, are filled with people from out of area", (NYM 11, AES).

Farmers in this group will exchange ideas and knowledge with other farmers on auction and market days but are unlikely to ring for advice. They occasionally ask advice from people outside of their network, but this is mainly the vet or RPA when dealing with BPS. However, some farmers participating in results-based AES pilot schemes will engage with subject matter experts in their non-agricultural/environmental groups. They do this to seek advice on best practice and ways to enhance habitat condition, through which they will see AES payments increase. There are similar levels of participation in social/church groups as with the non-AES groups with farmers seeing benefits of having social interaction.

"The benefits of the farm watch group are that it stops your quad bike getting nicked and hanging out with local farmers, which is good, there's not a huge social life around here", (YDNP 12, AES).

Farmers in the AES group have similar levels of bonding social capital to those in the non-AES groups as demonstrated by their involvement in groups with people of a similar occupation and background and their preference to turn to family over neighbours. Some, especially those involved in a results-based AES pilot scheme, see the benefits of accessing bridging capital to gain new skills and knowledge which in turn helps increase farm income and viability. More farmers in this category access linking social capital through involvement in village and parish council than in the non-AES group and this enables access resources which can benefit the community. This ability to access building and linking social capital may make farmers in this group more adaptable to change as they have access to knowledge and resource from groups outside of the farming network.

7.3.5. HNVF category

The HNVF farmers had the highest group participation rate across the non-agricultural/environmental (1.6/farmer), political/community (0.9/farmer) and social/church group types (1.2/farmer) and lowest in the agricultural/land-based groups (1.3/farmer) when compared to the other group categories. HNVF farmers rate non-agricultural/environmental groups as being the most important as it gives them access to a very diverse range of groups which they access for information and advice. These include, Yorkshire Dales flood facilitation management group, River, Wildlife and National Trusts, RSPB, Fferm Ifan (a Welsh Sustainable Management Scheme cooperative) and a variety of other groups covering a range of environmental and conservation issues (see Appendix 3, table S1 for a detailed description of the nature of these groups). Whilst many of the agricultural/land-based groups provide functional benefits, i.e., access to markets, the non-agricultural/environmental provide group members with additional benefits as seen in these quotes:

"I hope that we can make a sustainable farming future for the whole area [by being in the River Trust]", (YDNP 9, AES).

"For Fferm Ifan, I believe we're unique in the way that we manage land together. I hope it's going to bring a lot of resilience to my community as much as my own business. I want the whole community to thrive to be honest", (NW 3, HNVF).

The majority of the farmers in this group say they have more than five close friends and all bar one say that they could count on their neighbours. They all have people they could turn to in a short- or long-term emergency and four gave examples of how people both in and out of the farming community have come to help following an illness or accident. They interact regularly with other farmers and talk with people in non-agricultural/environmental groups monthly. Physical attendance in group activity is found to be higher in the non-agricultural/environmental and political/community groups than the agricultural/land-based groups. Fifty percent of the farmers in this category are involved in political/community groups such as village councils and national park authorities and participate in social/church groups more than those in the AES and non-AES groups seeing the benefits of interactions with people outside of the farming community.

"Being in a choir is more, it's like being in a football team, socialise, get your head from talking about farming", (NW 1, HNVF).

Farmers in the HNVF have already adapted farming practice from a more conventional production focussed approach to public goods approach. They have lower levels of bonding social capital and higher levels of bridging social capital that those in the AES and non-AES groups and this is demonstrated by the high levels of interaction with groups of people with different interests than farming. They access higher levels of linking social which gives them access to knowledge and resources which assists them in adapting to change. The results for group participation explore the types and structure of groups and how different types of social capital are accessed through groups. Trust and solidarity and how individuals interact with other people in the community also significantly impacts on the ability to access to social capital.

7.3.6. Trust and solidarity

Trust is an important factor for strengthening social capital (Fisher, 2013). Trust enables people to mobilise bridging and linking social capital and facilitate collective action which can give access to the knowledge and resources required to facilitate change (Hatak et al., 2016). Here the study presents data on trust towards neighbours, government officials, and strangers, and explores how individuals interact within the community and how perceptions of community have changed over time. Most participants in all three farmer categories agree, at least somewhat, that people within the community can be trusted and are willing to help (Table 7.3). However, further exploration identified differences between the groups in perceptions of community. The non-AES and AES categories perceive the local community as split between the farming and other community, with the 'other' community containing non-farmers and 'incomers. There is a perception that rural community life, especially within national parks, is changing for the worse and that change is predominantly driven by incomers, "If you had asked this 20 years ago [level of trust], I would have said 90% but now with people moving into the village I would say I would trust people in the village 10% but farmers and family, yeah I would trust most of them", (NYM 12, AES). A perceived lack of knowledge and a disregard for the ways of the country erodes trust between the farmer and the incomer. Many incomers are retirees or have holiday homes so are not seen as being able to help. This is exemplified by the statement "Most are not in a position to help. The people that are here don't need to be here and spend their time going somewhere else. Holiday homes, people who have made a lot of money or are retired, solicitors, doctors and people like that" (NYM 1, AES). They are seen to be bringing 'city' ways into the countryside for example, loud music, dogs and changes which divide and change the community, "They divide. Incomers like to divide; they like to do their own thing, so locals don't get involved. They had a band concert the other night, dogs were all stressed up because all this music is going and they wonder what's going on", (YDNP 2, AES). There are high levels of trust within the immediate family and farming community but low levels of trust of incomers can also extend to farmers outside of the immediate community, "All the ones I trust, I talk to them, the ones what I don't trust, I just say "hello, it's a nice day" but I don't talk about farming because if they know what you have, they could go and pinch it" (YDNP 11, non-AES).

In contrast, within the HNVF group levels of trust are higher with the majority not seeing incomers as an issue, "There is a divide, but I don't adhere to it. In personal terms, I would disagree with that", (YDNP 7, HNVF). However, like the non-AES/AES groups there are some who see divide in the wider community and trust only the farming community, "Within the farming community locally, nobody would take advantage of you. A lot of the families within the farming community here are 2nd and 3rd generation. The other community. If you have a dead sheep, they will be ringing up, they wouldn't ring you, they would ring trading standards", (NYM 2, HNVF). There is no significant difference in perceptions of local and central government between the groups. Farmers in the non-AES group have low-medium levels of trust in local government compared to low-high in the AES and HNVF groups. However, this changes for central government where the AES group have low-medium levels of trust compared to low-high in the non-AES and HNVF groups. Negative opinions are shaped through either personal experience, "We have a completely useless MP, he just behaves like a postman, you go to see him and he takes some notes and says he will do things and you never hear from him again" (NYM 14, HNVF) or a lack of interaction with government officials, "I don't have direct contact with local government officials so it can't be a very big figure [level of trust]", (NYM 16, AES).

Levels of trust and solidarity within a community are what create community cohesion and increase the ability to access the social capital needed to adapt to change. Farmers in the non-AES and AES groups demonstrate lower levels of trust in non-farmers and incomers than those in the HNVF group. They feel the community is divided, there is no social cohesion and some feel they need to be alert and aware of others in the community. This along with high levels of trust in the farming community indicates high levels of bonding social capital and lower levels of bridging social capital. In contrast, the HNVF groups do not see a divide and do not feel the need to be alert. They have higher levels of trust in non-farmers and incomers and see the benefits of interaction with people in these groups. This indicates that the HNVF group have higher levels of bridging social capital than those in the other groups. As agricultural and environmental policy moves towards a SLM approach to land management cooperation and collective action, gained though accessing bridging and linking social capital, will potentially be a valuable asset to those adapting to change.

7.3.7. Collective action and cooperation

Farmers in the HNVF group are more likely to contribute both time and money to community projects that do not have a direct benefit to themselves than those in the non-AES/AES groups. A lack of time to contribute to projects is a theme running across all groups but in the non-AES/AES groups, community divide and a lack of trust in incomers creates a barrier to both time and financial contributions as shown here, "It didn't benefit me at all and not the agricultural community? It's only a small village. I knew everyone but now I doubt if I know a quarter of them. So, why should I contribute to something that's not going to benefit me directly?" (NYM 6, AES). Collective action and cooperation can only happen if there is trust and social cohesion. The perceptions of community divide seen in the non-AES and AES groups is also reflected here where a willingness to contribute time and money to projects which benefit the wider community is lower than in the HNVF group. Again, indicating high bonding social capital in the non-AES and AES groups and high bridging social capital levels in the HNVF group.

Table 7.3. Participant perceptions of community, the levels of trust felt towards different groups within the community and the willingness to contribute time and money to community projects.

Category	People willing to help	Need to be alert	Community divide	Community	Local government	Central government	Farmers	Non-farmers	Incomers	Contribute to community (Money)	Contribute to community (Time)
Non-AES	Yes	Divided	Yes	High	Low to medium	Low to high	High	Medium to high	Low to high	Even split Yes/No	Even split Yes/No
AES	Yes	Divided	Yes	High	Low to high	Low to medium	High	Low to high	Low to medium	Majority No	Even split Yes/No
HNVF	Yes	No	No	High	Low to high	Low to high	High	High	Medium to high	Majority Yes	Majority Yes

7.3.8. Information and communication

Participants were asked to identify three sources they utilise to access information on government policies and actions and three sources they utilise to gather information on markets and to assist with decision making on the farm. The small sample size makes it difficult to identify significant differences between the categories of farmer in the ways in which they access information. All three categories utilise a wide range of sources to give them information on both the government and the markets. The following section discusses how the groups communicate with other people and how they use media sources to access information.

7.3.8.1. Communication

Bonding social capital is accessed by all three farmer categories to gain information on what the government is doing and for information to help with decision-making. Matriarchal/patriarchal figures are often accessed first for information, “Advice from my father would be number one. Then talking to friends would be number two”, (NW8, HNVF). The strong relationships formed with other farmers, friends and neighbours are also a source of bonding social capital that can be accessed for information and often these three things merge, “Relatives friends and neighbours and other farmers which are all interlinked”, (NYM 4, Non-AES). Markets provide a place for people from different locations, but the same background, to meet and exchange knowledge and ideas on both markets and what the government is doing. However, discussion groups with other farmers, “I quite like having discussion group meetings because you always seem to bring something away from it”, (YDNP 14, Non-AES) and social interactions, “I make a point of talking to people, I always have done, on Monday I sat down with the local farmers over lunch just talking about what is happening”, (NYM 9, Non-AES) are also important ways of accessing bonding social capital.

Bridging social capital is accessed through communication with others outside of the farming community and this is demonstrated here by two of the HNVF category, “I would say conversations but not necessarily with farmers, unlikely to be with farmers, so more with conversations with bodies such as the Parks Trust and environmental NGOs", (YDNP 7, HNVF); "We had a scything event here. We put a talk on and there's a very good local cheese shop here and he supports a lot of small cheese producers, we invite him here and then they go and get a talk on micro-dairies" (YDNP 6, HNVF). Communication is one way of accessing information the other is through media.

7.3.8.2. Information

Traditional media sources; TV, radio, national newspapers and magazines are used by farmers in all categories to access information on what the government is doing. These sources are also used for access to market information but through specific sources e.g., radio, "We listen to the radio, listening to farming in the morning", (YDNP 9, AES) or the farming press, "I look at Welsh Government mailboxes whenever they send circulars, again with Hybu Cig Cymru (Welsh Meat Production). It's usually Farmer's Guardian, to see what's going on", (NW 5, Non-AES). All three farmer categories access the internet and see benefits in doing so. It is used to access information on the markets, "My father used to have time to go to the auctions every week but I don't have time so before we go to sales, I check the prices at the local auctions", (YDNP 2, AES); to get up to date, trustworthy information, "You kind of trust it and it is up to date. The problem with the farming press is that when you read it it's already out of date", (YDNP 3, non-AES); to gain access to a wider information base, "It opens up more doors; scientific papers, veterinary papers", (NW 5, non-AES) and to reduce isolation, "If you can't get away anywhere, you can talk to them online. We can be stuck in for a week sometimes (YDNP 11, non-AES). The internet gives farmers, often isolated for long periods of time, access to their immediate networks (bonding social capital) and to wider networks (bridging social capital). There were however, two farmers in the AES category who say they never access the internet, "I don't watch TV and I don't go on the internet cause, I don't have time", (NYM 1, AES). Interestingly both of these farmers also say they either don't have or do not watch TV. This shows strong bonding social capital which can have an impact on social cohesion and inclusion.

7.3.9. Social cohesion and inclusion

If farmers are to reduce farm inputs and GHG emissions they may be required to cooperate more and share resources with neighbouring farmers and others in the community (Eriksen and Selboe, 2012; Hyland, 2015). Therefore, social cohesion and the way people interact within the community is important. However, "communities" are not single entities, but rather are characterized by various forms of division and difference that can lead to conflict (Grootaert et al., 2004). Here the study seeks to identify where divisions and conflict occur. Farmers in all three groups state that differences between people negatively impact upon the community to varying degrees. However, the HNVF group showed higher levels of bridging social capital than the AES/Non-AES groups. Twenty-three percent of the HNVF did not feel that differences between people impacted upon community life whereas all the non-AES/AES groups indicate that it caused a negative impact. In the non-AES/AES groups, ~65% believed that these differences caused problems compared to ~65% of the HNVF group who did not. Cultural differences between incomers and long-standing members of the community provide the main source of conflict. A perceived lack understanding of countryside and rural culture amongst those moving into the area from more urban locations creates problems, "The people who come into the district are not Yorkshire and they don't know what Yorkshire's like. They think they can behave as if it was the same as where they've been, and they often can't", (NYM 16, AES). These perceptions drive divisions between groups with differing interests. The incomer view of country life often differs from that of the farmer, leading to complaints and objections, "I think that the incomers don't understand about the countryside, don't necessarily want to learn about it, they object to some of the things which they see happening like fox hunting or pheasant shooting", (NYM 16, AES). However, farmers also have complaints about the incomers, "Incomers who have the dogs think, we're in the country now, I can let my dog loose. Somebody who'd been born and bred here wouldn't turn his dog loose because he knows he's going to chase sheep", (NW 6, AES).

Wealth, often linked to incomers, also creates division. People coming into rural locations are usually financially self-sufficient often coming to the country to retire or to buy second homes. People are prepared to pay for the well-being effects of cultural ecosystem services such as clean air and water, aesthetics and recreation and this in turn drives up property prices to the point where the local populace often feels excluded, "This is a very popular area for retired people and that pushes the prices of property way beyond the levels that young people can afford. None of them are here anymore", (YDNP 8, HNVF). Changes to the farming community, namely larger farms and less farm workers often causes isolation and leads to non-deliberate causes of division, "They [changes] impact upon me, lack of soulmates, lack of people to talk to, different attitudes. I get on okay with people, but I find I'm not on the same wavelength in terms of attitudes and stuff. I would like to feel closer to people but if they don't think the same way as you well that's life, (NYM 4, non-AES). Some see differences between people as positive, "I don't think that those differences cause a great deal of issue in the community. I almost think it's a positive thing, to be honest. I think in the village people who have moved in have contributed to making the village a better place", (YDNP 7, HNVF) whilst others acknowledge that cultural barriers exist within the farming community, "The farming community has a no change approach to life, they are worried about change. This is what my father did, my grandfather did, my great grandfather did. why should we change?", (YDNP 5, HNVF). The strong bonding capital shown here can be beneficial to those within the farming community. Farmers who connect to one another, create shared goals and a sense of unity and can empower the community and build their collective efficacy to address issues that affect their communities (Collins et al., 2014).

7.3.10. Empowerment and political action

Individuals are "empowered" to the extent they have a measure of control over institutions and processes directly affecting their well-being (World Bank, 2002). This section explores how participants react to proposed political change and what actions they have taken to influence and adapt to change. Participants across all groups stated they voted in the latest UK general election, and all non-AES and HNVF participants and 83% of the AES group voted in the EU referendum. 75% of the HNVF group attended government-led consultation meetings or completed a consultation paper on the future of farming post-Brexit compared to 30% of the AES group and 20% of the non-AES group. Across all groups there are some who think Brexit will have a significant impact on their business, some who think it will have a slight impact and some who think it will have no impact. For example, within the AES group there were two participants who do not believe there will be any significant changes to the payments system and are not really thinking about it, "I've not thought about it, you just bury your head in sand don't you really", (YDNP 13, AES). Most participants, across all groups, recognise that change is inevitable, and many are adapting farming practices or considering options for change in the future. Of those non-AES participants considering changes, only one is considering diversifying into environmental goods. Others are considering changes to production practices and breeds, reducing input costs and off-farm diversification. In the AES group, two are considering making efficiency changes whilst the remainder are either waiting to see what comes, ignoring the fact that change is inevitable or preparing to leave farming if things get economically unviable. The majority believe that they currently farm in a way that will attract environmental payments and some are considering moving further down that route by further reducing stock and embracing more options to deliver public goods and changing farming practice to become more efficient.

7.4. Discussion

"Social capital" refers to features of social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit (Putnam, 2000). Conventional wisdom says that social capital is stronger amongst rural communities than urban communities due to perceived strong interpersonal relationships and mutual obligations (Hofferth and Iceland, 1998). However, communities, which are notoriously vague and troublesome to define (Dinnie and Fischer, 2019), are dynamic with an ever-changing flow-through of people, money and ideas (Callaghan and Colton, 2008) and these changes have the potential to impact upon levels of social capital within the community. Change is occurring in both the farming and wider rural community. According to recent estimates, the population of rural areas is growing faster than urban areas with growth occurring fastest in less sparse villages and hamlets (Commission for Rural Communities, 2011). Urban to rural migrants, normally aged 45-74 (Commission for Rural Communities, 2011), move to the countryside for business reasons, to retire or to chase the 'Rural Idyll', which views the countryside as an idealized, romanticized construct that presents rural areas as happier and healthier, with more neighbourly communities and fewer problems than urban areas (Osbaldiston, 2009; Rogers et al., 2013; Gaspar, 2015; Stockdale, 2016). As demonstrated, many of the old structures of rural communities e.g., the village council and the local agricultural shows are well supported however, the participants are not just locals with generational ties to the community. They are now joined by the professional home-worker, the office-worker/commuter and the retired bank manager who bring different cultural and social ideals (Rogers, 1989; Burton et al., 2005). The role of farmers and farm workers within the social structure of the community has significantly changed due to these demographic and social changes. The farmer still has social standing but they find themselves alongside the retired professional or commuter on the parish of village committee (Rogers, 1989). These changes are exaggerated further by changes to farming community structures which have driven a decline in the levels of social capital generated through the communal sharing of tasks within the local community due, in part, to the farmer having less time to interact with other members in the community (Burton et al., 2005).

Decreasing income and the severe pressure to respond to a changing economic, social, political, technological and natural environment has led to a reduction in the number and an increase in the size of agricultural holdings across Europe (European Commission, 2013) affecting farm businesses and the life of farming families (Alsos et al., 2011). Economic divide has existed in rural communities since Victorian times. However, the influx of incomers with a higher-than-average income potentially sees the rich minority become the majority and the economic divide between the minority and majority increase (Roger, 1989). The degree at which intermixing or polarisation between incomers and established members of the community will very much depend on both the nature and intensity of the rural idyll imported by the incomer and the degree to which individuals within the locality cling to cultural heritage (Cloke and Milbourne, 1992). As farmers' roles in local communities diminish, the co-operative action between them, and between them and local villages, is likely to diminish and with it their social capital generated (Burton et al., 2005). Here it is shown that structural and demographic changes to the wider communities in which our farmers live, have led to an erosion in communication levels between farmers, especially the non-AES and AES groups, and the community outside of their immediate network. A lack of polarisation between the incomer and the farmer can increase the importance of the markets, auctions and agricultural groups to which the farmer belongs. Farmers come together to compare practices, catch up and gossip and exchange complaints, they can reassure themselves that they are doing things right (Hills, 1988) increasing bonding social capital and potentially creating barriers which may make it more difficult to adapt to change. The findings demonstrate this occurring within the study communities by showing that a primary reason for an erosion of trust between the farmer and the incomer is perceptions that ‘incomers’ have a perceived lack of knowledge and a disregard for the ways of the country. This is especially prevalent in the non-AES and AES communities where participation in agricultural groups and social events is highest. Levels of trust are high within the inner circle of family and friends but much lower when that circle is extended to the wider community or even to other farmers. These groups are also those most likely to think that divisions within the community cause problems and this also impacts upon levels of trust. Within the non-AES and AES groups an inward-looking view of community, and a lack of trust in those out-with the immediate family/friendship network, supports the view that levels of bonding capital are higher in these groups than bridging capital. However, the importance of these networks and the role of knowledge cultures (Morris, 2006) in the development of more environmentally sustainable farming systems is not to be underestimated.

In recent years the UK, and other European countries have seen the CAP progressively become ‘greener’. Science has been called upon to assess the environmental damage caused by production-based agriculture and policy has changed to identify more sustainable pathways of development, most notably in the form of AES (Riley, 2008). The policy knowledge culture of prescriptive AES casts farmers and land managers as lacking the necessary knowledge about how to manage their land appropriately and therefore dictates how management practices should be implemented (Morris, 2006). However, the intimate and experiential knowledge of how the natural environment ‘behaves’ in the particular circumstances of the farm often sees farmers contest scheme prescriptions and challenge the policy knowledge culture (Morris, 2006). The ‘one size fits all” (Mettepenningen et al., 2013) nature of prescriptive AES leave little flexibility (de Krom, 2017) preventing farmers from utilising generations of local knowledge and this tends to create barriers between the scientists/policymakers and the farmer

(Riley, 2008). If policymakers are to increase participation in AES and encourage farmers to adopt ELMS, they must pay attention to the complex and deeply socialised understandings and knowledge cultures of farmers in order to understand how they may play a role in the countryside managements of the future (Riley, 2008).

The HNVF group view differences in the community as less problematic and have higher levels of trust of those outside of their immediate network than those in the non-AES and AES groups. They have the most diverse range of groups with membership of agricultural groups being the lowest and membership of non-agricultural and political groups being higher than both the AES and non-AES groups indication high levels of bridging and linking capital (Cofré-Bravo et al., 2019). This interaction with people and groups outside of the immediate farming network allows for greater access to research-based knowledge, innovative experiences, and training and financial resources (Adler and Kwon, 2002; Mills et al., 2008). This may open opportunities for diversifying forms of production and business models not available to the AES and non-AES groups. Participants in the HNVF group demonstrate higher levels of linking capital than the other groups through their participation in political groups and membership of National Park boards. These high levels of linking social capital enable the HNVF participants to engage vertically with external agencies, giving them the ability either to influence their policies or to draw on useful resources (Pretty and Smith, 2004). In contrast, the lack of trust and relationships with government bodies in the more conventional farming groups means that levels of linking social capital between farmers and government representatives are limited and this may limit access to funding and training opportunities (Mills et al., 2008).

A UK exit from the EU will mean change for farmers but for some their ability to change may be hindered by social capital levels in the immediate and wider community, whereas for others social capital will enhance their ability to adapt (Woolcock, 1998). Here it is shown that farmers in the non-AES and AES groups have higher levels of bonding capital and lower levels of bridging and linking capital that those in the HNVF group. Social capital, especially bridging and linking capital, is essential for maintaining and enhancing public goods whose value can be maintained only through co-operation and trust, and whose value is lost through the pursuit of individual self-interest (Wilson, 1997). Hall and Pretty (2008) found farmers with sustainable farms had success-based identities and stronger feelings of self-efficacy about their interaction with government agency staff. Farmers with high bridging and linking social capital tend to have better social skills, higher self-esteem and self-efficacy which enables them to overcome frustrations when dealing with government agencies and other organisations (Cast and Burke, 2002; Hall and Pretty, 2008). In contrast, strong bonding capital, seen in the non-AES and AES groups, builds social capital links based on mistrust and a desire to protect the group from the outside (Wilson, 1997). This potentially disempowers the farmer making them feel strongly averse to contact with government agency staff (Hall and Pretty, 2008).

This study has shown the HNVF group to have high levels of bridging and linking social capital. This has enabled and supported a transition from a conventional production approach to farming to a more extensive, nature friendly farming approach delivering 'public goods' and has potentially placed them in a better position to access the knowledge and resources needed to adapt to future policy. If more conventional farmers with high bonding and low bridging and linking social capital are to effectively build the social capital required to ensure the viability of rural communities, the government must shift from acting as controller, regulator, and provider to new roles as catalyst, convener, and facilitator (Potapchuk et al., 1998). They must encourage differing dimensions of the rural community to cooperate and forge better relationships for the benefit of all. A local advisory service, staffed by people with good understanding of local conditions and the ability to use integrated knowledge to see the farm business as a whole, will increase social capital by improving dialogue and understanding between farmers and other stakeholders (Mansfield, 2019). Improved relationships with stakeholders who have a vested interest in rural communities will ensure not only the production of high-quality sustainable food, but a range of public goods and services of which the whole of society benefits (Mansfield, 2019). If local farmers and community members can overcome communication barriers and work together as partners to create a sustainable local food system it has the potential to increase the whole community's vitality and sustainability (Brehm and Eisenhauer, 2008).

7.5. Conclusion

The findings of this study show how social and demographic change has impacted upon farming communities. As farmers' roles in local communities diminish, the co-operative action between them, and between them and local villages, is likely to diminish and with it their social capital. It shows farmers in the non-AES and AES groups demonstrating high levels of bonding capital which brings them together as a farming community but creates barriers to interaction with people and groups outside of the immediate network. The high levels of bonding social capital, created by divisions in the community, has the potential to create barriers to policy adoption through an inward-looking perspective which is resistant to change. In contrast, farmers in the HNVF group have high bridging capital and an outward-looking approach to relationships and networking. They are already adapting to change, engaging with a wide variety of networks and embracing the public goods approach to land management that is likely to increase the likelihood of the farmstead remaining viable post-Brexit. If more conventional farmers are to build the social capital, they need to adapt to forthcoming change they will need government support, through training, mentoring and facilitation, to help introduce and manage new relationships and to provide the knowledge and advice required to remain viable in the face of change.

Conflict of interest

The authors confirm that there is no conflict of interest with the networks, organisations, and data centres referred to in the paper.

Acknowledgements

Funding: This work was supported by the FLEXIS (Flexible Integrated Energy Systems) programme, an operation led by Cardiff University, Swansea University and the University of South Wales, and funded through the Welsh European Funding Office (WEFO). Special thanks go to Rebecca Thomson at the North York Moors National Park, Helen Keep at the Yorkshire Dales National Park, Mark Hughes of the Llanfairfechan Grazing Association and the National Trust, Ysbyty Ifan Cooperative for helping arrange the interviews, and all of the farmers who gave up their time to participate. I acknowledge the academic input of the three anonymous reviewers who provided very useful insights on the original manuscript.

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Chapter 8

Exploring viable upland farming systems compatible with net zero carbon targets

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This manuscript is under review with Land Use Policy

D.A. designed and conceived the research. D.A. conducted the analysis of the data and prepared the manuscript. All authors discussed results and contributed to preparation of the manuscript.

8.1. Introduction

Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C, creating an increased risk of more frequent heatwaves, droughts and flood events (CCC, 2018a; IPCC, 2018). In December 2015, the UK and 195 other countries reacted to this global threat by signing the Paris Agreement which commits them to pursue a low greenhouse gas (GHG) emissions and climate-resilient pathway (HM Government, 2017). However, in the UK it is clear that further action is needed, in all areas, if the legally binding fourth (2023-2027), fifth (2028-2032) and sixth (2033-2037) carbon budget targets are to be met, and GHG emissions are to be reduced to 'net zero' by 2050 (HM Government, 2017; CCC, 2018b; CCC, 2020a). The CCC, who advise the UK and devolved governments on emissions targets (CCC, 2018b), state that, "a transition to net zero carbon in the agricultural sector requires a transformation in the use of land with around 9% of agricultural land being needed for actions to reduce emissions and sequester carbon by 2035 and 21% needed by 2050" (CCC, 2020a). The 'Balanced Net Zero Pathway' of the UK's sixth carbon budget (CCC, 2020a), recognises that it is not possible to completely decarbonise the agricultural sector due to the inherent biological and chemical processes in crop and livestock production, but it presents options to reduce and offset these emissions (CCC, 2020a).

Measures which if implemented could release land from agriculture include: diet change (a 20% shift away from meat and dairy products by 2030, with a further 15% reduction of meat products by 2050); a reduction in food waste (halved across the supply chain by 2030) and productivity improvements (sustainable intensification and increased stocking rates through improved grasslands; CCC, 2020a). It is estimated that these measures could release ~2 million hectares of land which could be used for less-intensive farming (e.g., agroecology farming), to deliver deeper emissions reduction i.e., plant trees on 10% of farmland and extend hedgerows by 20% by 2035 (CCC, 2020b) and conversion to other uses e.g., wildflower meadows and natural regeneration (CCC, 2020a, CCC, 2020b). Farmers, who have a significant role to play in enabling net zero targets, also face changes to agricultural policy, including additional environmental targets, e.g., Nitrate Vulnerable Zones, (Defra, 2018b), and Clean Air Strategy (Defra, 2019; Welsh Government, 2019a), that if becomes law, will require ammonia emission reduction, and increased biodiversity goals. In Wales, The Water Resources (Control of Agricultural Pollution) (Wales) Regulations 2021 will apply from 1 April 2021 for an initial set of measurements, with further nutrient management, manure and silage storage and water pollution measures regulations being phased in over a period of 3 years (Welsh Government, 2021). The Basic Payment Scheme (BPS), which pays farmers per hectare of agricultural land, will be removed and replaced with an Environmental Land Management Scheme in England (ELMS; Defra, 2018b) and a Sustainable Land Management Scheme in Wales (SLMS; Welsh Government, 2019b). These schemes propose an approach making it possible for farms to produce positive environmental outcomes alongside sustainable food production. Sustainable land management (SLM) incorporates environmental, economic, and social outcomes and it is hoped that by supporting the delivery of environmental outcomes, future schemes may indirectly contribute to the delivery of these outcomes (Defra, 2018b; Welsh Government, 2019b).

In Wales, farmers are the largest group of land managers with land on farms and commons covering 1.86m ha (88% of the total land area; Welsh Government, 2017a). Eighty percent of the total agricultural land is designated as Less Favoured Area (LFA; Armstrong, 2016; Appendix 4; SF1) i.e., an area with natural handicaps (lack of water, climate, short crop season and tendencies of depopulation), or that is mountainous or hilly, as defined by its altitude and slope (OECD, 2002). The LFA is further divided into the more environmentally challenging severely disadvantaged areas (SDA) and disadvantaged areas (DA; Defra, 2017). The soil quality, climate and geography of Wales mean that most of the agricultural land (81%) is under grass, with arable accounting for only 13% (Welsh Government, 2017a). These restrictions, and the high numbers of grazing livestock, make it potentially difficult for Wales to reach net zero carbon by 2050 (CCC, 2020). Despite this, the Welsh Government has agreed to a 95% carbon reduction in GHG emissions by the year 2050 relative to 1990 (Welsh Government, 2019c; Thistlewaite et al., 2020; Appendix 4; ST1). These factors make Wales a meaningful exemplar area to explore the feasibility of upland farming systems to reach zero C goals.

The removal or reduction of BPS could leave many UK upland beef and sheep farms economically non-viable (Wallace and Scott, 2017; Dwyer, 2018; Shrestha et al., 2018; Arnott et al., 2019). On average, upland cattle and sheep farms have a negative income net without BPS payments or other subsidies e.g., agri-environment payments (Welsh Government, 2019d). To maintain viability, many farmers will need to find new and creative solutions to this potential crisis (Roberts, 2014; Wilkinson, 2020; Manzoor et al., 2021). Post-subsidy removal, they may consider changing land management practices to qualify for proposed environmental subsidies (Manzoor et al., 2021), diversify or seek alternative employment, or downsize or de-intensify their farming operation (Morris et al., 2017; Dwyer, 2018; Mansfield, 2019). Should land become available, one option may be to increase farm size, as evidence shows that pursuing economies of scale can be a successful strategy for upland farms to improve performance, in terms of efficiency and occurrence of profitability (Vigani and Dwyer, 2020). The introduction of payment for public goods schemes such as the SLMS and ELMS may present opportunities for upland farmers to receive payments to use their livestock as a tool for existing habitat conservation, rather than for food production (Arnott et al., 2019; Manzoor et al., 2021) and to convert some of their land to forestry (Cowie et al, 2018).

Scaled up case study farms (CSFs) have previously been used to better understand the complex dynamics of land use and land cover change (Gomes et al., 2019); to assess the possible effects of policy and market change scenarios on potential financial, land use and labour employment in mountain areas in Europe (Morgan-Davies et al., 2017) and to estimate GHG emissions from beef production using lifecycle assessment (LCA) tools (Beauchemin et al., 2010). This study takes a similar approach using real CSFs to create representative farms which are scaled up in order to:

- Create and explore land use change scenarios.
- Assess the economic and social benefits and risks arising from land use change scenarios.
- Identify how land use change in the uplands can contribute to Welsh and UK low-emission production (LCA) and net zero carbon targets and,
- Identify possible wider (international) consequences, e.g., animal production displacement.

Wales is used as a study area as it has less opportunity for CO_2 storage and relatively high agricultural emissions that are hard to reduce (CCC, 2018a). The UK's exit from the EU opens the possibility that in future, dynamics around the CAP may be different. Whilst there is no evidence that Brexit is driving CAP reform, there is growing dissent in Member States and farming communities against perceived bureaucracy and overly complex administration (De Ville and Siles-Brügge, 2019). As a result of a UK exit the EU budget will reduce by ~€12 billion yr^{-1}. This has the potential to drive reform in the EU's two biggest programmes, the CAP and structural funds, which may reduce by ~€80 billion over seven years (about 13 %) leading to reductions or capping of direct payments (De Ville and Siles-Brügge, 2019). These potential changes in payments to the EU agricultural sector, linked with the EUs commitment to GHG reduction, make this paper of interest to an international audience.

8.2. Methodology

Here, CSFs that have adapted in anticipation of subsidy reform and future demand for public goods are used to create viable farm typologies, and associated land use change scenarios, in order to explore how the beef and sheep grazing livestock sector can contribute to a net zero GHG balance and other ecosystem services. Figure 8.1 shows the framework used to assess the impact of land use change scenarios on UK climate change targets (CCC, 2020a) and the social, economic, and environmental sustainability of the upland sheep and beef grazing livestock sector. The study focuses on three farm typologies representative of important land categories: severely disadvantaged farms (SDF), disadvantaged farms (DF) farms (which are both in the LFA grazing category) and lowland farms (LF). Baseline carbon footprints for each typology was created using farm data from the 2017 June Agricultural Survey (Welsh Government, 2017a) with potential future scenarios being created by adjusting farm profiles using CSF profiles as templates. Three CSFs were selected from across the UK to reflect differences in farm size and land type. These CSFs have adopted different approaches to farm in a more extensive, and potentially more sustainable, manner. Two of the three farms have commons rights but do not exercise them. A transition towards representative viable farm profiles based on the CSFs was then considered to out scale realistic land use change scenarios rather than downscale from top-down approach as many other papers (CCC, 2000a). The Agricultural Resource Efficiency Carbon Footprint Calculator (AgRECalc; Sykes et al., 2017; SAC Consulting, 2019) was used to determine GHG emissions, and emissions intensities of production, for the grazing livestock sector across the land use change scenarios. The results of the study are used to identify how potential land use change could impact on the social, economic, and environmental sustainability of the upland grazing livestock sector in the context of net zero GHG targets.

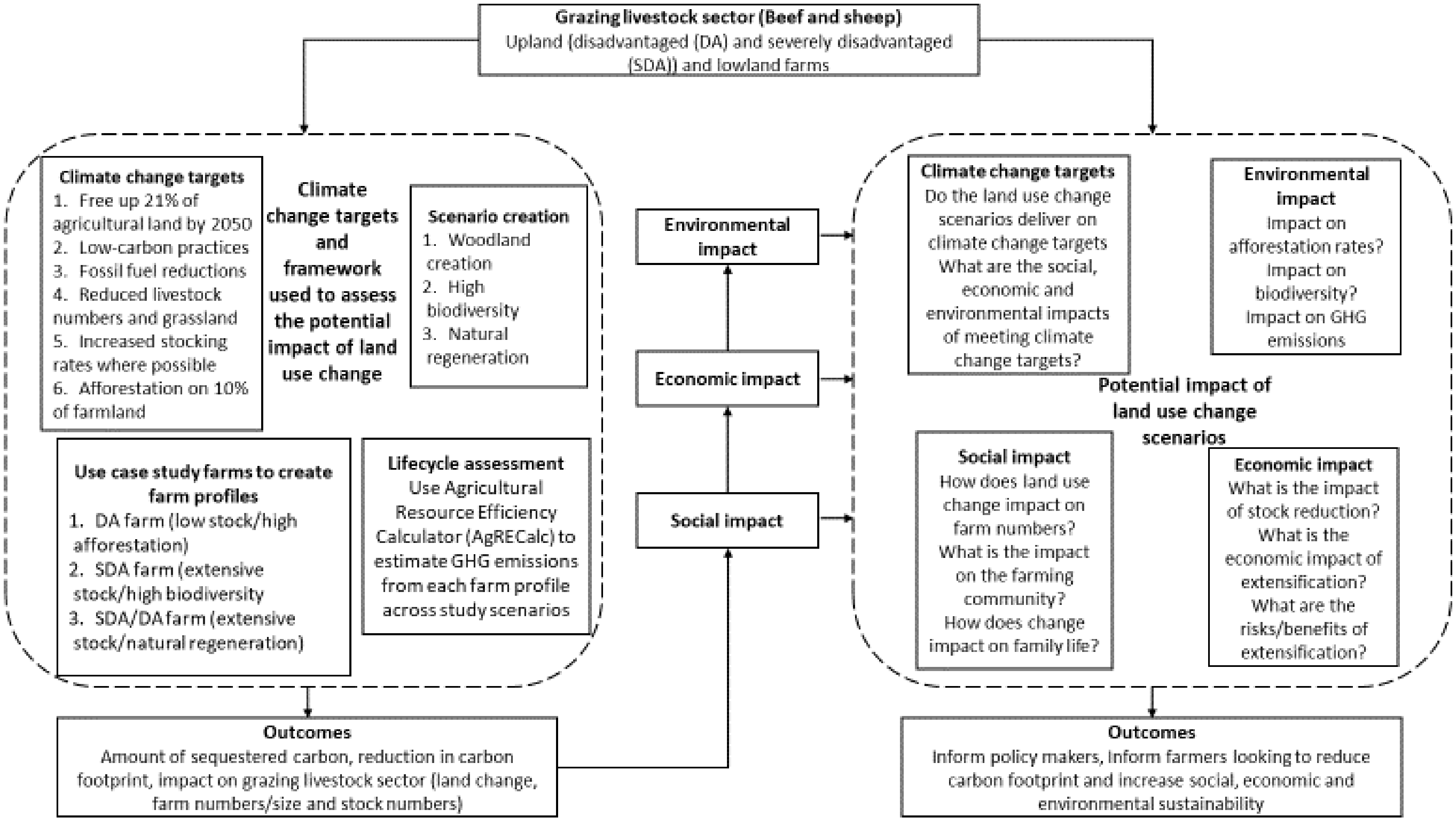


Figure 8.1. Primary UK climate change targets for the agricultural sector and the framework used to assess the impact of various land use change scenarios.

8.2.1. System boundaries and assumptions

LCA is a well-established technique used to assess the environmental impacts associated with the delivery of a product or service (Wiltshire et al., 2019). Its magnitude is influenced by the system boundaries applied (Hyland et al., 2016). For beef and lamb enterprises, most system boundaries are set from ‘cradle to farm gate’, where all direct and indirect emissions are incorporated into a footprint, from the birth of an animal until such time it leaves the farm for slaughter, and accounting for upstream production of inputs (e.g., fertilisers and feed) to the farm (Hyland et al., 2016). The assessment includes all ‘cradle to gate’ activities over one calendar year of operation, assuming a relatively constant herd profile.

8.2.1.1. Territorial boundaries

The territorial boundaries for the assessment include farms across the SDA, DA and lowland beef and sheep grazing livestock sector in Wales but exclude common land (defined in the British context as: land owned by one person over which others have the right to harvest resources. In short, the rights to harvest resources are held in common, not, as many would believe, that access to resources is for all. To harvest resources, one must have commons rights but access to common land for recreation is for all. Mansfield, 2018a) as details for common land and its usage are not included in the dataset used to create farm profiles. At the farm scale, AgRECalc includes the land and buildings used in the beef and sheep enterprises of interest.

8.2.1.2. The Agricultural Resource Efficiency Calculator

The Agricultural Resource Efficiency Calculator (AgRECalc; Sykes et al., 2017; SAC Consulting, 2019) determines on-farm GHG emissions at the enterprise, area and product level, and is most widely used to compare the GHG intensity (i.e., “carbon footprint”) of food production (Sykes et al., 2017; March et al., 2019; Sykes et al., 2019). AgRECalc was selected for use in this assessment as it has been used in the Scotland Beef Efficiency Scheme to assess approximately 1400 beef enterprises (Wiltshire et al., 2019). Full details of model functionality are presented in Sykes et al. (2017).

8.2.1.3. Activities and materials

AgRECalc assessment is based on all activities arising within, and materials used on, the farm, including emissions from the production of inputs not produced on the farm, such as manufactured fertilisers. The farm gate is defined as the point at which a live animal is taken away for slaughter, and no emissions are considered after this point. Therefore, the following parts of the lifecycle are excluded: transport from the farm, slaughter, carcass preparation, further processing and packaging, further transport, retail, consumption, waste processing (Wiltshire et al., 2019).

8.2.1.4. Sequestration (removals)

AgRECalc includes sequestration for some carbon sinks (e.g., farm woodland) but most studies have traditionally not included soil carbon sequestration in carbon foot printing calculations due to methodological limitations (Brandão et al., 2012). In this study other possible sinks are not included because of high uncertainty.

8.2.1.5. Emissions calculations

IPCC Tier II (2006) calculations are employed to calculate livestock and manure management emissions. Emissions from production of fertilisers and pesticides ('embedded' emissions) are calculated using Carbon Trust (2010) emission factors, whilst nitrous oxide (N_2O) emissions from synthetic and organics fertilisers, animal excretions and crop residues follow IPCC (2006) Tier I methodology. The tool also calculates embedded emissions for imported feed and bedding, based on emission factors (EFs) from Kool et al. (2012). Electricity, renewable energy, and fossil fuel emissions are calculated using emission factors from Defra/DECC (2011) Conversion Factors for Company Reporting. Finally, carbon sequestration from woodland is calculated using IPCC (2006) methodology at Tier I level. The online tool is certified under the PAS2050:2011 specification for GHG life cycle assessment (British Standards Institution, 2011; Sykes et al., 2017; March et al., 2019; Sykes et al., 2019). The calculator outputs the quantity of GHG produced from routine farm activities, highlighting areas where changes can be made that, when implemented, will reduce emissions. The three main GHGs produced from agriculture include CO_2, produced by burning fossil fuels; methane (CH_4,) produced as a natural by-product of ruminant digestion and; N_2O which is released from soils following nitrogen inputs (fertiliser, manure, urine and dung deposited by grazing livestock) and soil disturbance (Penman, 2006; Hyland et al., 2016; IPCC, 2018).

8.2.1.6. Assumptions

Farm structures are configured based on the case studies, but farm structures differ and there will be variations across the sector. Assumptions made on the number of farms becoming non-viable, post-BPS removal are based on FBS data and research which predicts that high proportions of farmers will become non-financially viable without BPS (Wallace and Scott, 2017; Bateman and Balmford, 2018; Dwyer, 2018; Shrestha et al., 2018; Arnott et al., 2019). In scenario 2: high biodiversity and scenario 3: natural regeneration, assumptions are made that landowners/managers adapt to meet increased opportunities to secure farm income through woodland creation and AES. This study does not take into account that agricultural land and forestry ownership is fragmented across many individuals and organisations across the UK or that there is a potential need for 3rd party organisations to manage larger woodland areas on farms. Owners and tenants can often have different motivations for farming land, making the targeting of new land use policies challenging (CCC, 2019). The removal of BPS may see a level of economic resistance to change as farmers fight to remain on the land, but financial collapse is a very real threat for some farming communities. While temporary abandonment of land is a possibility, long term this is more likely to lead to the consolidation of smallholdings into larger units (Bateman and Balmford, 2018). In addition, farmers can be very traditional in their thinking and do not always readily adapt to change, therefore there is likely to be cultural inertia within the farming community, with farmers exploring other options to maintain productivity (Burton et al., 2008).

8.2.2. Case study farms

Here, three CSFs were selected from across the UK to reflect differences in farm size and two land types, DF and SDF, particularly likely to be impacted by direct subsidy removal (Wallace and Scott, 2017; Bateman and Balmford, 2018; Dwyer, 2018; Shrestha et al., 2018; Arnott et al, 2019). Table 8.1 shows the land profile and stocking rates for the CSFs before and after changes to farming practice (full details of the CSFs can be found in Appendix 4; 1.1-1.3). Farm activity data were collected from farm records pre- and post-extensification. These data were then entered into the AgRECalc carbon footprint calculator (SAC Consulting, 2019) in order to calculate the GHG emissions at the farm, area (per ha) and product (e.g., per kg live weight beef/sheep) level (Appendix 4; ST3).

Table 8.1. Land profiles and stocking rates for the three case study farms before and after changes to farming practice. Land set aside for biodiversity includes fallow land, field margins or land left for natural regeneration.

	CSF 1		CSF 2		CSF 3	
Year	2013	2019	2012	2019	2009	2019
Land areas (ha)						
Rough grazing	107	83	360	360	427	1298
Permanent pasture	17	18	62	52	70	66
Silage or hay	13	0	20	30	40	0
Biodiversity	0	0	0	0	72	177
Seasonal land	25	0	0	0	0	0
Total Grazing Land (ha)	162	101	442	442	609	1541
Woodland	7	25	8	8	28	440

Roads and infrastructure	3	3	0.2	0.2	2	2
Total Land (ha)	172	129	450.2	450.2	639	1983
Livestock numbers[1]						
Suckler cow	3	0	19	60	40	45
Bull	0	0	7	5	2	2
Heifer 24-36 month	0	0	15	10	4	14
Heifer 12-24 month	0	0	10.5	7	5	7
Heifer 0-12 month	2	0	15.5	16	15	9
Steer 24-36 month	0	0	4.5	29	0	12
Steer 12-24 month	0	0	5	10	3	10
Steer 0-12 month	2	0	0	16	18	16
Male entire 0-12 month	0	0	2.5	0	0	0
Total Cattle	7	0	79	153	87	115
Ewes	377	26	337	115	335	443
Tups	0	2	20	7	14	13
Hogg	53	7	19	0	89	120
Gimmer	0	0	112	0	0	110
Shearling	0	0	78	48	0	0
Lamb	238	19	82	131	371	481
Total Sheep	668	54	648	301	809	1167
Stocking rate/ha (Cattle)	0.04	0.00	0.2	0.4	0.1	0.07
Stocking rate/ha (Sheep)	4.1	0.5	1.5	0.7	1.3	0.8
% area of land in woodland	4%	19%	2%	2%	4%	22%
Total fertiliser input (kg/ha/yr)[2]	100	0	0	0	0	0
% Nitrogen (pasture/silage)	20/15	0	0	0	0	0
% Phosphorus (pasture/silage)	10/15	0	0	0	0	0
% Potassium (pasture/silage)	10/15	0	0	0	0	0
FYM Cattle (t/ha/yr)[2]	0	0	0	0	1	0

[1]Livestock numbers are the average monthly stock holdings over a one-year period. [2] Fertiliser input and FYM totals are simple crude averages to provide an indicative of level of production intensity.

8.2.3. Scenarios

8.2.3.1. Farm typologies

Farm data from the 2017 June Agricultural Survey (Welsh Government, 2017a) were combined with BPS payments data obtained from Rural Payments Wales (RPW) by the Welsh Government's Agricultural Statistics Office (ASO) using the County, Parish, Holding (CPH) code (Welsh Government, 2017b). Each farm in the dataset is classified by;

- Farming typologies* (SDF, DF and LF).
- Economic size (based on Standard Output on a farm).
- Area of land (survey estimate excluding the use of common land).
- Level of Pillar 1 plus Pillar 2 payment (£).
    - None (farms receiving no BPS payment),
    - Under 10 (farms receiving <£10k),
    - 10 to 20 (farms receiving £10-20k),
    - 20 to 40 (farms receiving (£20-40k) and,
    - At least 40 (farms receiving ≥ £40k).

*Farm typologies used are an adjustment of the standard Robust Farm Types (Defra, 2014).

The study assumes there will be no change to farm structure on very small farms and on farms not in receipt of BPS as they are less likely to change to farming practice in response to policy change than those receiving direct support (Barnes et al., 2019). It uses evidence from recent studies, which estimate ~55% of LFA beef and sheep farms will be non-viable post-subsidy removal (Shrestha et al., 2018; Arnott et al., 2019; Barnes et al., 2020), to explore how the upland grazing livestock sector would change should this occur. It assumes that land released from these farms will be purchased and redistributed between other farms in the same farm type. Table 8.2 shows the average farm size before and after restructuring and the percentage of farms removed. The total holdings in each farm type, after restructuring, provided the initial structure around which a baseline and potential land change scenarios were created. To establish a sector GHG baseline, six farm typologies were created, SDF and SDF (‘None’), DF and DF (‘None’) and LF and LF (‘None’). Average farm size was established by averaging farm size across each of the farm types. The SDF and DF beef enterprises were classed as Breeder/Finisher, Spring Calving Hill Sucker Cows, and the sheep enterprises as Store/Finisher Extensive Hill Ewe Flocks. The LF beef enterprise was classed as Breeder/Store, Spring Calving Lowland Suckler Cows and the sheep enterprise as Store/Finisher, Crossbred Ewe Flocks. Total cattle numbers, comprising dairy, beef, calves and others (bulls, steers and heifers) and total sheep numbers were extracted from the ASO dataset. There are some dairy cattle recorded as being on SDF and DFs, but as numbers are so small (~2 per farm) they have been classed as other cattle. The ASO dataset identifies the total land area by land use (permanent grassland, rough grazing, new grass, silage and hay, cereals, stockfeed, other crops and woodland and other uses including buildings, yards and roads). These data were scaled up to a sector level by collating the total number of farms, land use and livestock number across each of the six typologies, SDF, SDF (‘None’), DF, DF (‘None’), LF and LF (‘None’). These data were then used to create a farm structure for each farm types and for the total sector (SI; 1.4: Farm structure). The scaled-up totals from each section of the farm profile were then entered into the AgRECalc carbon footprint calculator (Sykes et al., 2017; SAC Consulting, 2019) to give a baseline carbon footprint for the entire farmed area across each of the six farm types.

Table 8.2. The number of holdings and land on holdings for each of the farm types and payment brackets and the average farm size for holdings in 2017, the holdings deemed to be at risk (Arnott et al., 2019) and the number of holdings and average farm size after the deduction of at-risk farms.

Farm type	Payment bracket	Number of current Holdings	Land on holdings (ha)	Average farm size (ha)	Holdings at risk after subsidy removal	% at risk	Number of holdings after at risk losses	Average farm size after at risk losses (ha)
SDF	None	1,897	98,011	52	0	0%	1,897	52
	< £10k	1,814	72,639	40	1,239	68%	575	126
	£10-20k	1,526	140,042	92	1,437	94%	89	1574
	£20-40k	1,434	230,062	160	1,027	72%	407	565
	≥£40k	854	305,471	358	327	38%	527	580
Total		7,525	846,224	112	4,030	54%	3,495	242
DF	None	1,442	40,424	28	0	0%	1,442	28
	< £10k	1,542	54,327	94	1,090	71%	452	94
	£10-20k	818	70,768	795	788	96%	30	795
	£20-40k	382	54,463	134	273	71%	109	134
	≥£40k	117	29,410	56	37	32%	80	56
Total		4,301	249,393	58	2,188	51%	2,113	82
LF	None	963	24,893	26	0	0%	963	26
	< £10k	805	29,677	37	511	63%	294	52
	£10-20k	439	36,561	83	415	95%	24	411
	£20-40k	190	28,279	149	122	64%	68	69
	≥£40k	51	11,453	225	11	22%	40	22
Total		2,448	130,864	53	1,059	43%	1,389	51

8.2.3.2. Farm profiles

Farm profiles were created for each of the farm types using the AgRECalc data input sheet as a template (SAC Consulting, 2019; Appendix 4; ST2). The ASO dataset gives a total area for ‘woods and other areas’. To meet AgRECalc requirements this land area was further broken down into woodland type (broadleaf and conifer) and other area use (buildings, yard, and roads). Average data collected from the CSFs were used to allocate the 'woods and other areas' land as 50% broadleaf, 40% Conifers and 10% roads and buildings. Data from the UK Cattle Yearbook (AHDB, 2018a) and UK Sheep Yearbook (AHDB, 2018b) were used to classify and allocate a percentage of total cattle and sheep into detailed cohorts (bulls, cows, heifers, steers and calves (male and female) and ewes, tups, hoggs, gimmers, shearlings and lambs). The yearbooks were also used to identify percentages of deaths and to create sales profiles for the farms. The British Survey of Fertiliser Practice (Defra, 2018c) was used to determine average fertiliser application rates and percentages of nitrogen (N), phosphorus (P) and potassium (K) applied to areas of permanent pasture and cut grassland. Average yields per ha were determined using yield data taken from EBLEX (2014) and crop allocation (% of crop allocated to sheep and cattle), manure management and feed and bedding data were established through analysis of CSF management data. Where specific data were not available for farm typologies, "industry standard" data e.g., average liveweights (lwt) by stock type, at weaning and at slaughter, were applied in AgRECalc (Sykes et al., 2017; SAC Consulting, 2019). These data also included the average amount of crop removed, the average lwt, the average weight at weaning and the average weight at one year or at slaughter. Benchmarking data collated by Hybu Cig Cymru – Meat Promotion Wales (HCC, 2019) – were used to determine average calving and lambing percentage and the percentages of lamb singles, twins, and triplets. Average electricity and fuel use data was sourced from the Farm Business Survey (FBS; Defra, 2013). Average volume of water use and plastic waste generation (litres/ha and kg/ha) were determined by averaging across the three CSFs. These data and the farm profile template were used to create a model of the total sector data for entry into AgRECalc (Appendix 4; 1.4: Farm profiles). The model was then adjusted to create sector profiles for each to the six farm typologies.

8.2.3.3. Scenario creation

The CSF profiles were extrapolated to create future farm structure and land use scenarios. Farm profiles for the SDF, DF and LF (None) categories were assumed to remain unchanged across all scenarios. Fig. SF2 shows the main changes to farm structure and land use that formed the basis for the land use change scenarios used to estimate GHG emissions from farm profiles in SDA, DA and Lowland grazing sectors. Detailed farm profile structures for each scenario can be found in Appendix 4; 1.4: Farm structure. All scenarios see changes to livestock numbers with significant reductions occurring on SDF and DF farms especially in sheep numbers (Table 8.3). LF scenarios see some of the displaced livestock moving from SDF/SF to the lowlands.

Table 8.3. Percentage change in livestock numbers across land use change scenarios compared to a baseline.

Scenario/Farm type	Cattle numbers	% ±	Sheep numbers	% ±
Baseline DF/SDF	453,820		8,731,124	
Scenario 1 DF/SDF	320,966	-29%	1,527,439	-83%
Scenario 2 DF/SDF	343,009	-24%	1,481,382	-83%
Scenario 3 DF/SDF	77,870	-83%	1,441,755	-83%
Baseline LF	117,667		657,343	
LF all scenarios	178,352	52%	1,254,620	91%

8.2.3.3.1. Scenario 1: Low input

The SDF profile was changed to match that of CSF 2. Some permanent pasture and land allocated to stock feed and cereals was reverted to wildflower hay meadows with no fertiliser input. Cattle stocking rates remain at 0.4 but sheep stocking rates were adjusted to match the more extensive stocking rates of CSF 2 (0.7). AgRECalc industry standard data (SAC Consulting, 2019) were used for average lwts across the SDF, DF and LF profiles. The Welsh

Government's Woodland Opportunities Map (Welsh Government, 2020c) shows potential woodland creation occurring on DA and Non-LFA land. As CSF 1 had significantly increased woodland on the farm it was used to create the DF profile for scenario 1. Farm size remains the same. Stock feed, cereals and cut grassland were removed as a land use and the land was allocated to woodland. Cattle are removed from DFs and sheep stocking rates adjusted to match those of CSF 1. Ewes are housed for 10% of the time, all other sheep are permanently outdoors spending 60% of the time on in-bye land (land that is not hill and rough grazing) and 40% on rough grazing. In the LF category, stock feed, cereals, fertiliser and all management, sales and resource usage remain as the baseline. Average stocking rates in the LF category were below the higher percentiles rates shown in AHDB (2018b) so were adjusted up to 2.2 cows/ha and 15 sheep/ha in order to identify the potential for (sustainable) intensification of lowland systems to compensate for reduce livestock out from upland areas. Land freed up through intensification was allocated to woodland (Welsh Government, 2017b). LF profiles are the same across all three profiles.

8.2.3.3.2. Scenario 2: High biodiversity

SDF and DF profiles were combined as an increase in farm size means farms will likely straddle both DA and SDA land, given the complex distribution of these classifications within the highly variable landscape of the uplands. Farm size and woodland coverage and diversity increase, whilst permanent pasture reduces. Stocking rates and managing practices mapped those of CSF 2. There is no fertiliser use and the number of hectares in high biodiversity, wildflower meadows increase. Ewes and tups are housed 5% and 45% of the time, respectively. Cattle remain outdoors all year round, are kept longer and are not sold until the upper end of each age category e.g., heifers and steers 24-36 months would not be sold until 36 months and those at 12-24 would be sold at 24 months. This reflects lower growth rates for more extensive systems (HCC, 2014).

8.2.3.3.3. Natural regeneration/woodland creation scenario

SDF and DF profiles were combined as an increase in farm size means farms will straddle both DA and SDA land. Farm size and woodland increase, and 10% of the total land use area is set aside for natural regeneration/biodiversity which will support net zero carbon targets by sequestering carbon for decades as they revert back to their carbon-rich intact state (Lewis et al., 2019). This is achieved through a concurrent reduction in the amount of land in permanent pasture. The percentage of land in hay meadows is lower than in the other scenarios as natural regeneration increased and no fertiliser is used. Ewes are housed 5% of the time and tups for 45%. Cattle remain outdoors all year round, are kept for longer and are not sold until the upper end of the category e.g., heifers and steers 24-36 months would not be sold until 36 months and those at 12-24 would be sold at 24 months.

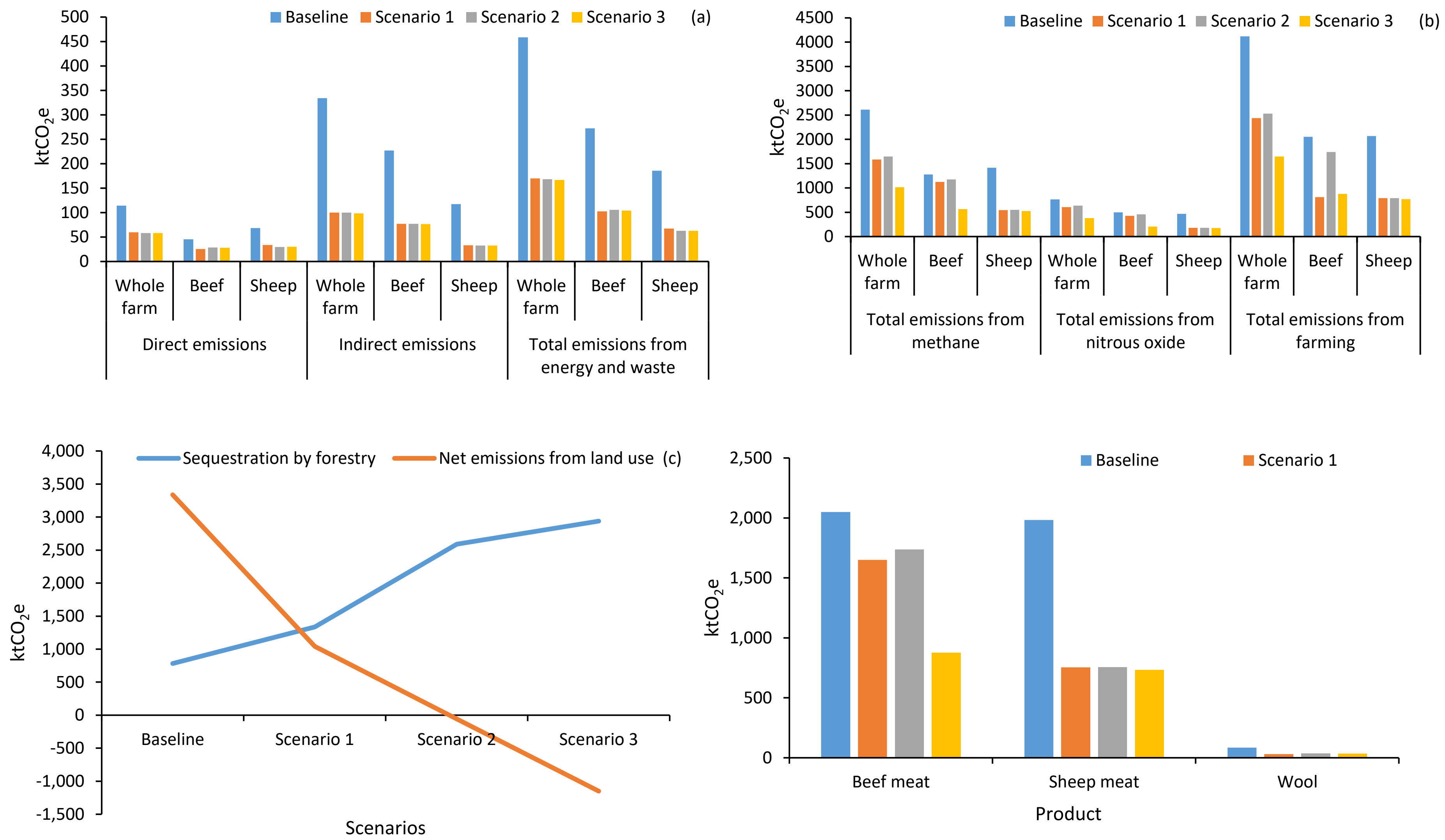
8.2.4. Carbon sequestration and GHG emission calculations.

AgRECalc (Sykes et al., 2017; SAC Consulting, 2019) was used to estimate GHG emissions from each farm profile in the study farm types. In scenario 1, the results of the individual farm profiles (SDF, SDF (None); DF, DF (None) and LF, LF (None) were combined to give three carbon footprints SDF, DF and Lowland (Appendix 4; 1.4: Profile emissions). These were combined to give a total carbon footprint for scenario 1 (Appendix 4; 1.4: Scenario emissions). In scenarios 2 and 3 the findings from the combined SDF/DF profiles were added to the 'None' and Lowland profiles to give total carbon footprints for the scenarios. Emissions are calculated for the whole farm and per enterprise (sheep and beef production) e.g., direct CO_2 (energy usage: fuel, electricity); indirect CO_2 (inputs, feed, bedding, disposal of carcasses); CH_4 (enteric fermentation, manure management) and N_2O (direct emissions, N deposition, leaching and run-off) and CO_2e emissions per kg of farm output i.e., product CO_2e emissions (kgCO_2e/kg lwt; kgCO_2e/kg wool). These footprints were analysed to identify which scenarios had the greatest impact on overall GHG emissions, and emissions intensities of production (meat footprints), from the grazing livestock sector.

8.3. Results

8.3.1. GHG emissions summary

Figure 8.2 provides a summary of emissions from CO_2, CH_4 and nitrous oxide N_2O for the whole beef and sheep farming sector, per enterprise and per unit of saleable product. Fig. 8.3a/b shows the total CO_2e emissions from production, fig. 8.3c shows net CO_2e emissions from land use and the total ktCO_2e sequestered in forestry, fig. 8.3d/e shows product emissions and fig. 8.3f emissions per hectare. Total CO_2e emissions from farming reduced to 2,440 ktCO_2e in scenario 1, 2,531 ktCO_2e in scenario 2 and 1,646 ktCO_2e in scenario 3 compared to 4,120 ktCO_2e in the baseline. ktCO_2e sequestered by forestry increased to 1,338 ktCO_2e in scenario 1, 2,588 ktCO_2e in scenario 2 and 3,292 ktCO_2e in scenario 3 compared to 782 ktCO_2e in the baseline. This sees net emissions from land use reduce to 1,041 ktCO_2e in scenario 1, -58 ktCO_2e in scenario 2 -1,150 ktCO_2e in scenario 3 compared to 3,337 ktCO_2e in the baseline (Appendix 4; 1.4: Percentage change). Detailed production and product emission changes for each enterprise are discussed in the scenario summaries below and shown in Appendix 4; 1.4: Percentage change.



(a)
Baseline
Scenario 1
Scenario 2
Scenario 3
ktCO2e
500
450
400
350
300
250
200
150
100
50
0
Whole farm
Beef
Sheep
Direct emissions
Indirect emissions
Total emissions from energy and waste
(b)
4500
4000
3500
3000
2500
2000
1500
1000
500
Total emissions from methane
Total emissions from nitrous oxide
Total emissions from farming
(c)
Sequestration by forestry
Net emissions from land use
4,000
3,500
3,000
2,500
2,000
1,500
1,000
-500
-1,000
-1,500
Baseline
Scenario 1
Scenario 2
Scenario 3
Scenarios
2,500
2,000
1,500
1,000
Beef meat
Sheep meat
Wool
Product

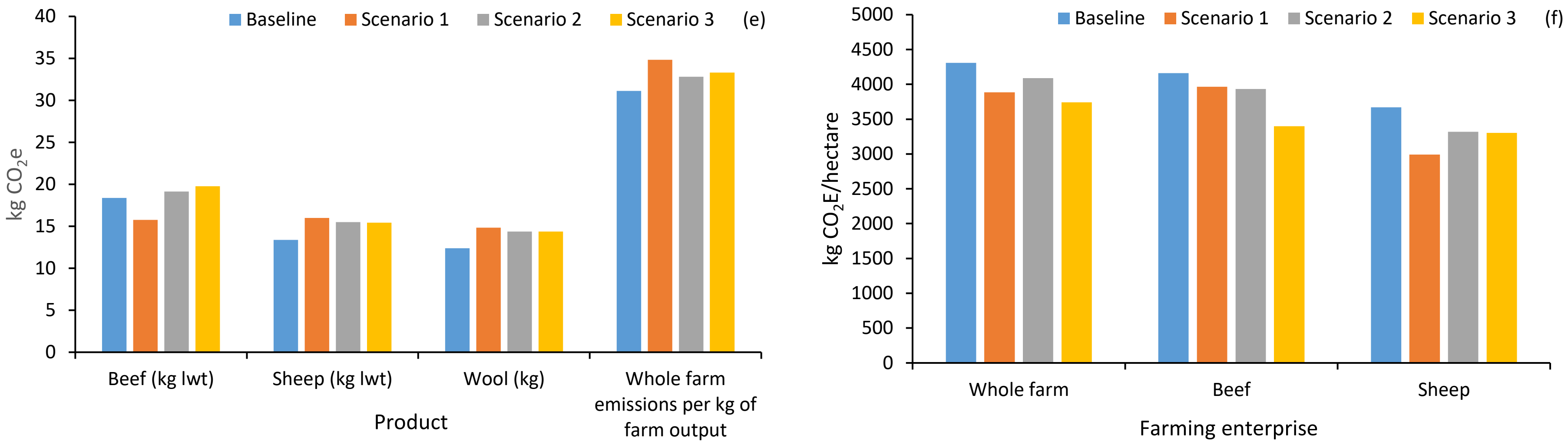


Fig. 8.2. Summary of emissions from carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) for the whole beef and sheep farming sector, per enterprise and per unit of saleable product. (a). CO_2 emissions (direct, indirect and from waste and energy); (b). CO_2e emissions from CH_4, N_2O and total emissions from farming; (c). kt CO_2e sequestered in forestry and net emissions from land use; (d). Product emissions (kt CO_2e); (e). kg CO_2e/kg lwt for the beef and sheep sectors and kgCO_2e/kg wool and (f). Emissions per hectare (kgCO_2e/ha).

8.3.2. Scenario 1: Low input

8.3.2.1. Production emissions, C sequestration and net emissions from land use

In scenario 1, whole farm direct CO_2 emissions reduce by 48% (beef,44%; sheep, 50%), indirect CO_2 by 70% (beef, 66%; sheep, 72%) and CO_2 from energy and waste by 63% (beef, 62%; sheep, 64%; Fig. 8.3a). Whole farm CO_2e from CH_4 reduces by 39% (beef, 12%; sheep, 62%; Fig. 8.3b) and whole farms N_2O emissions reduce by 21% (beef, 15%; sheep, 62%; Fig. 8.3b). Total CO_2e emissions from farming reduce by 41% (beef, 60%; sheep, 62%; Fig. 8.3b). Total CO_2 sequestered in forestry increases by 71% and net GHG emissions from land use are reduced by 69% (Fig. 8.3c). Despite these changes the grazing livestock sector is still a net source of 1,040 kt CO_2e (Appendix 4; 1.4: Percentage change).

8.3.2.2. Product emissions

Total kgCO_2e in the beef enterprise reduces by 19% (Fig. 3d) and kg CO_2e/kg lwt reduces by 14% (Fig. 8.3e). Total emissions per livestock unit (kgCO_2e/LU) also reduce by 19%. The reduction in sheep numbers means total kgCO_2e in the sheep enterprise reduces by 62% (Fig. 8.3d) but the more extensive nature of the system means kg CO_2e/kg lwt increases by 19%. Total kgCO_2e from wool production decreases by 64% but kg CO_2e/kg wool increases by 19%. Total emissions per livestock unit (kgCO_2e/LU) reduces slightly by 3%. Emissions per hectare (kgCO_2e/ha) reduce by 1% across the whole farm, by 5% in the beef enterprise and by 5% in the sheep enterprise (Fig. 8.3f).

8.3.3. Scenario 2: High biodiversity

8.3.3.1. Production emissions, C sequestration and net emissions from land use

In scenario 2, whole farm direct CO_2 emissions reduce by 49% (beef, 38%; sheep, 57%), indirect CO_2 by 70% (beef, 66%; sheep, 72%) and CO_2 from energy and waste by 63% (beef, 61%; sheep, 66%; Fig. 8.3a). Whole farm CO_2e from CH_4 reduces by 37% (beef, 8%; sheep, 61%; Fig. 8.3b) and whole farms N_2O emissions reduce by 17% (beef, 9%; sheep, 70%; Fig. 8.3b). Total CO_2e emissions from farming reduce by 39% (beef, 15%; sheep, 62%; Fig. 8.3b). Total CO_2 sequestered in forestry increases by 231% and net GHG emissions from land use are reduced by 102% (Fig. 8.3c). These changes mean the grazing livestock sector is now a net sink of -58 kt CO_2e (Appendix 4; 1.4: Percentage change).

8.3.3.2. Product emissions

Total $kgCO_2e$ in the beef enterprise reduces by 15% (Fig. 8.3d) but further extensification of the beef enterprise means kg CO_2e/kg lwt increases by 4% (Fig. 8.3e). Total emissions per livestock unit ($kgCO_2e$/LU) reduces slightly by 2%. The reduction in sheep numbers means total $kgCO_2e$ in the sheep enterprise reduces by 62% (Fig. 8.3d) but the more extensive nature of the system means kg CO_2e/kg lwt increases by 15%. Total $kgCO_2e$ from wool production decreases by 58% but kg CO_2e/kg wool increases by 16%. Total emissions per livestock unit ($kgCO_2e$/LU) reduces slightly by 4%. Emissions per hectare ($kgCO_2e$/ha) reduce by 2% across the whole farm, by 5% in the beef enterprise and by 8% in the sheep enterprise (Fig. 8.3f).

8.3.4. Scenario 3: Natural regeneration

8.3.4.1. Production emissions, C sequestration and net emissions from land use

In scenario 3, whole farm direct CO_2 emissions reduce by 49% (beef, 39%; sheep, 56%), indirect CO_2 by 70% (beef, 66%; sheep, 72%) and CO_2 from energy and waste by 64% (beef, 62%; sheep, 66%; Fig. 8.3a). Whole farm CO_2e from CH_4 reduces by 61% (beef, 56%; sheep, 62%; Fig. 8.3b) and whole farms N_2O emissions reduce by 50% (beef, 59%; sheep, 63%; Fig. 8.3b). Total CO_2e emissions from farming reduce by 60% (beef, 57%; sheep, 63%; Fig. 8.3b). Total CO_2 sequestered in forestry increases by 321% and net GHG emissions from land use are reduced by 134% (Fig. 8.3c). These changes mean the grazing livestock sector is now a net sink of -1,150 kt CO_2e (Appendix; 1.4: Percentage change).

8.3.4.2. Product emissions

Total kgCO_2e in the beef enterprise reduces by 57% (Fig. 8.3d) but further extensification of the beef enterprise means kg CO_2e/kg lwt increases by 8% (Fig. 8.3e). Total emissions per livestock unit (kgCO_2e/LU) remains the same as the baseline. The reduction in sheep numbers means total kgCO_2e in the sheep enterprise reduces by 63% (Fig. 8.3d) but the more extensive nature of the system means kgCO_2e/kg lwt increases by 15%. Total kgCO_2e from wool production decreases by 58% but kg CO_2e/kg wool increases by 16%. Total emissions per livestock unit (kgCO_2e/LU) reduces by 6%. Emissions per hectare (kgCO_2e/ha) reduce by 7% across the whole farm, by 18% in the beef enterprise and by 7% in the sheep enterprise (Fig. 8.3f).

Here reduced stock numbers and inputs occur on larger, more extensive farms, leading to a reduction in total CO_2e across the grazing livestock sector which, when combined with increased carbon sequestration in forestry, leads to the sector becoming a net carbon sink in scenarios 2 and 3. This study has not looked at the potential carbon sequestered through peat restoration. In scenario 2 and 3 there would undoubtedly be areas freed up for this type of public goods delivery. In Wales, semi-natural peatlands cover approximately 66,000 ha and if restored, emissions reductions of approximately 70 kt CO_2e yr^{-1} would be achieved (Welsh Government, 2019d) adding to the net sinks achieved by changes to farming practice and carbon sequestration in scenario 2 and 3.

8.4. Discussion

This study does not try to predict the future, or suggest that achieving environmental, economic, and social sustainability means farm numbers must significantly reduce. It aims to use indicative "what-if" scenarios to explore the biodiversity and GHG implications of farm adaptation following a worst-case scenario where significant numbers of upland farms become non-viable following subsidy removal EU. Actual farms transitioning from traditional hill farming enterprises to extensive farming practices are used as CSFs. These real farms have a focus on delivering public goods through adapted farming practises providing an enhanced and more resilient financial return to the farming enterprise. They therefore represent useful and unique “bottom-up” insight into potential large-scale land use transitions.

8.4.1. The case study approach.

The UK 25-year environment plan (Defra, 2018d), the Welsh Natural Resources Policy (Welsh Government, 2017c) and Land Use Policy for a Net Zero UK (CCC, 2020c) recognise that uplands are unique, and face different challenges to those faced by lowland farmers (Defra, 2018b) and that future patterns of farming may not be the same as current uses (Welsh Government, 2017c). Defra accepts that proposed policy changes will accelerate structural change, increase the rate at which farms cease trading and release land to the market (Defra, 2018e; Franks et al., 2019). These policies offer sustainable intensification advice (SI; Garnett et al., 2013) but environmental constraints mean that most upland farmers have no option but to accept the productivity limitations imposed by land quality constraints (Mansfield, 2008; Short and Dwyer, 2012; Mansfield, 2018b; Franks et al., 2019).

This study uses CSFs as potential templates of (more) economically viable upland farms within simplified, indicative scenarios to extrapolate possible GHG mitigation effects associated with farm adaptation to subsidy reform. This approach (Carolus et al., 2018; Maye, 2018; Conway et al., 2019) allows the use of real-life scenarios to explore farm-level complexities surrounding carbon balancing and GHG reductions across the grazing livestock sector. As individual farms, the CSFs adopted different strategies to enhance economic viability but they all intensified, reduced inputs and embraced farming practice which deliver environmental benefits. CSF 1 is a DF farm on land suitable for woodland creation (Welsh Government, 2020c). The strategy adopted by this farmer seen a significant reduction in livestock numbers and 20% of the land being planted with a mixture of broadleaf and conifer woodland. CSF 2 was already farming with low inputs; however, an economic assessment of the farming business found the sheep enterprise to be non-profitable. The main change on this farm was an increase in traditional cattle breeds and a significant decrease in sheep numbers. These changes see both farms becoming more economically sustainable and CSF 1 becoming a net carbon sink. Changes in farming practice on CSF 2 see emissions from farming rise on this farm as increased fattening times increases the carbon footprint of (much lower) production in these areas (Eldesouky et al., 2018). However, on this farm a conservation grazing approach and an increase in wildflower meadows delivers biodiversity benefits which are not quantified through an LCA. Land constraints on CSF 2 mean they do not have the option to offset the increase in livestock emissions through C sequestration in trees. If viewed individually, CSF 2 may be seen as less environmentally sustainable due to increases in GHG emissions, but it delivers high levels of biodiversity benefits through a conservation grazing approach. It is therefore important to view the sector as a whole. Scenario 1 explores how the sector would look if all DF farms adopted a CSF 1 approach and all SDF a CSF 2 approach. When viewed together the carbon footprint of the SDF/DF sector is seen to reduce as the carbon savings on DF farms offset the carbon increases on SDF farms. Scenarios 2 and 3 show how the sector can be a net C sink if farm size and woodland coverage increased and natural regeneration was introduced to offset increased product emissions. The scaling up of CSF practices in scenarios 1 and 2 see increases in cattle numbers but substantial reductions in sheep numbers. In scenario 3 the SDF/DF sector adopt a CSF 3 approach and reduces stocking rates and livestock numbers significantly as the sector moves towards a farming for public goods approach. In the context of these scenarios where livestock are just one component of multifunctional farms delivering biodiversity and other ecosystem services, e.g., clean water and flood alleviation, as well as sufficient carbon sequestration to achieve net zero carbon, farm and product level carbon footprints may not be relevant metrics of upland farm efficiency. There are significant trade-offs between carbon footprint and other relevant environmental, social, and economic variables. This is the main reason why carbon footprint alone should not be used for environmental and sustainability assessment (Picasso et al., 2014).

8.4.2. Socio-economic impact (farm size and numbers).

Profitability groups are defined by lining up farms in order of profitability from 1-100 (with 1st position being least profitable and 100th position being most profitable) and dividing these up into 10 groups (Defra (2018e), Based on profitability, it is estimated that on average, the bottom 10% (65% of which are grazing livestock or mixed farms) need to reduce inputs costs by 31% in order to break even (Defra, 2018e). Sheep farming in the UK without subsidies is only profitable if farmer and spouse labour are unpaid, even then, only the most productive farms break even (O'Neill et al., 2020). Leaving the EU will significantly affect the financial viability of a large proportion of upland farms, resulting in land use change affecting most of the country (Dwyer, 2018; Barnes et al., 2020; Manzoor et al., 2021). As part of the transition to a new agriculture policy Defra (2020):

- plan to 'delink' Direct Payments from the land for all farmers.
- will look to offer farmers a one-off optional lump sum payment in place of Direct Payments.

Delinking means that recipients will no longer have to farm in order to receive payments during the agricultural transition. It will give farmers an opportunity to invest in their business to boost productivity and profitability or diversify their activities. Some farmers may decide to stop farming altogether and use the payment to contribute to their retirement or move to another sector, something that is being considered by CSF 1. This would facilitate restructuring, creating opportunities for existing businesses to expand and new entrants to join the industry (Defra, 2020).

The CSFs used in this study all stated that economic viability had improved as a result of changes to farming practice, but CSF 3 was the only farm that was confident they would remain viable after complete subsidy removal. This economic sustainability is achieved through farm restructuring and economies of scale. Studies show that increasing farm size can help to improve efficiency and profits, up to a point (Vigani and Dwyer, 2020). However, the fact that upland farms operate under decreasing returns to scale suggests that enlarging the business scale will eventually reach limits, above which marginal productivity cannot substantially increase (Vigani and Dwyer, 2020). In the case of CSF 3, economy of scale and a move towards public goods delivery means income not only comes from food production. Approximately 29% of land on the farm has been planted with trees, ~11% is being allowed to naturally regeneration and the whole farm is entered into AES all of which generate income. An increase in farm size by 40% to 1,541 ha means this farm has more livestock than it did before extensification, but the size of the farm means that stocking rates are drastically reduced. The use of traditional breeds which live outside all year round reduces the labour burden on the farmer, "giving the farmer a life back" (CSF 3). This has social benefits within the household and wider social networks. The social benefits gained by moving to less labour-intensive traditional breeds were also seen as a positive by CSF 2 who also has additional income from AES. CSF 2 showed that reduced inputs, shift to traditional cattle and a reduction on the non-profitable sheep enterprise meant that the livestock enterprise was now a net contributor to farm income but despite this the farmer says they may struggle without BPS payments. CSF 1 planted 20% of the farm area with trees and livestock numbers were reduced in an attempt to become financially viable. The farm is now a carbon sink and woodland creation payments contribute to farm income, but this income is not equivalent to that received through BPS. CSF

1 will consider putting more of the farm in trees as direct payments reduce and is prepared to put the whole farm in AES and woodland creation schemes.

The Welsh Government (2019b) states, “SLM focuses on the sustainable use of resources, meaning these resources can continue to be productive, as long as the productive system operates within natural limits. This is productive both in an economic and social sense”. The ‘natural limits’ of the uplands severely restrict the farmer’s ability to increase productivity (Franks et al., 2019) therefore farmers will need to find new and creative solutions to the potential crisis arising from subsidy removal (Manzoor et al., 2021). The scenarios used in this study extrapolate case study farming practices to explore how the beef and sheep sector would look if all farmers adopted these farming practices. In these scenarios a shift in farming practice significantly reduces costs, increases the return on investment from livestock enterprises and, despite higher kg CO_2e kg/lwt, reduces overall CO_2e across farms. However, under scenario 1, a shift towards an extensive, but more profitable farming model, does not necessarily equate to economic sustainability on SDF and DF. These farms may struggle financially following subsidy reform if future payments for public goods are not similar to that of BPS. In scenario 2 and scenario 3 farmers are able to increase farm income through economy of scale by accessing woodland creation and further AES payments and potential income from schemes like the woodland carbon code (West, 2019). Provenance and heritage are important to the consumer and they have often been forgotten in the race to be low-cost. Naturalness such as grass-fed and outdoor reared have the potential to appeal to consumers’ nostalgia. If farmers are able to create a brand and tell compelling product stories, they have the potential to sell their product at premium prices (Stannard, 2018). In addition to increasing farm income and farm viability, these measures offset GHG emissions and contribute to biodiversity (Wallace and Scott, 2017). SI and the ability to plant trees means lowland farmers, already more economically stable, are less at risk that those in the LFA (Arnott et al., 2019).

There are social consequences (positive and negative) that result from changing farm structure (Lobley et al., 2005) and this is noted across the scenarios. As farm size increases to incorporate smaller, less efficient farms, farmers are displaced (Dwyer, 2018). Some may take a lump sum payments in lieu of relevant payments (HM Government, 2020) and retire, some will leave farming and look for other work (WRO, 2010), but some may become unemployed and this is likely to impact on the social structure of the region (Dwyer, 2018). Whilst the scenarios used in this study explore land use change and farm restructuring to investigate how these changes would impact on the farming sector in Wales, the implications of this study are also relevant in the other devolved nations of the UK and have resonance with work being conducted on land abandonment, primarily caused by a diversity of social, political, and economic factors, across the globe (e.g., Dolton-Thornton, 2021).

8.4.3. Implications of reduced sheep output.

The CSFs found the sheep enterprise part of the business to be a significant drain on financial resources. CSF 1 made the decision to reduce total livestock numbers (cattle and sheep) and move towards tree planting. During a financial audit of the enterprise CSF 2 identified the point at which the enterprise created loss. Sheep stock numbers were reduced to sustainable numbers which reduced input costs and made the enterprise a net contributor to the business. An increase in farm size means that the number of sheep held by CSF 3 increased but significantly reduced stocking rates means that when scaled up to a national level stock numbers drop significantly. If all farmers adopted similar farming practices to those of the CSFs sheep numbers would reduce by >75% (7.5 million) across all scenarios. Some of this reduction (~1.3-3.2 million sheep and lambs), will be accounted for in the 20-50% reduction in red meat consumption needed for the UK to be carbon neutral by 2050 (CCC, 2020c: ESC, 2020) and ~600,000 will be absorbed by increasing stocking rates in the lowlands but the remainder will be displaced. Displacement is in keeping with the principles of land-sparing and

SI i.e., increasing yields on productive land whilst sparing native vegetation or freeing up land for habitat restoration elsewhere (Pretty and Bharucha, 2014; Phalan, 2018). That is assuming that displaced production is compensated by SI rather than being compensated by farms with lower environmental and welfare standards. In Wales, only 20% of agricultural land is designated as LF (Armstrong, 2016). As the scenarios show, those more productive areas are unable to sustainably intensify enough to absorb all of the livestock displaced from the LFA (Elliot et al., 2013). In 2016, the average stocking rate for lowland sheep in England was 0.9 LSU/ha (AHDB, 2016a) which is much lower than the suggested high stocking rate of 2-2.5 LSU/ha (0.8-1 LSU/acre) shown in AHDB (2016b). This, combined with potential productivity gains coming from technological progress and intensification in the lowlands (Qi et al., 2018) suggests potential for some sheep production to move from Wales to more productive lands in England with more extensive farming practices in Wales delivering carbon sequestration and ecosystem services. This would however, require a coordinated UK-wide governmental approach; providing advice, technical support and if necessary higher levels of public goods funding (CCC, 2019) in order to pay for the ecosystem services that contribute to making human life both possible and worth living e.g., food and water, flood regulation, soil health, recreation and spiritual benefits (UK National Ecosystem Assessment, 2014). If the UK is unable to increase production to meet future consumption (CCC, 2019; CCC, 2020c) there is a serious risk of production being ‘off-shored’ to other agroecosystems (McKay et al., 2019) leading to decreases in agriculture-related emissions achieved in the LFA being cancelled out or even exceeded by emissions resulting from production and transport of produce from overseas (Evans et al., 2019). Indirect consequences of livestock production and land use changes often manifest via complex cascades that are difficult to predict, requiring consequential LCA of many scenario permutations (Styles et al., 2018). There remains a need to build on the detailed bottom-up national scenarios developed here with a broader consequential LCA of upland land use transitions

8.4.4. The role of upland farms in delivering public goods and net zero GHG emissions.

Using CSFs this study shows that upland farms can contribute significantly to the delivery of ecosystem services and the reduction of GHG emissions. In Wales, there is a significant imbalance in the delivery of ecosystem services from upland land use, notably underperformance in the provision of public goods when agricultural and forestry land use are considered together (Hardaker et al., 2020). Despite having a strategy which sets out a commitment to biodiversity (Welsh Government, 2015) on average, Wales' wildlife has declined in recent decades (State of Nature Partnership, 2019). All three scenarios shown in this study support Franks (2019) by demonstrating that the way to improve sustainability in LFAs is not through intensification but through an approach which reduces inputs and the adoption of extensive farming practices. This approach delivers significant benefits to flora and fauna biodiversity and reductions in GHG emissions, but there are trade-offs. Significant restructuring of SDF and DF farms would see a reduction in the number of farmers and a significant reduction in livestock numbers in the uplands. If net zero GHG emission (CCC, 2019; CCC, 2020c) and biodiversity targets (Welsh Government, 2015) are to be met, land use across the UK will have to fundamentally change. Carbon foot printing of the CSFs shows that net zero carbon is attainable (even carbon positive), but natural and farm size constraints means this is not the case on all farms. Policymakers should acknowledge this at the broader scale when working to meet agricultural GHG reduction targets, whilst simultaneously promoting GHG mitigation and carbon sequestration measures at the farm level on all farms. The land sharing versus sparing debate is often elaborated at a coarse spatial grain (i.e., large blocks of internally homogenous land; Fischer et al., 2014) that disregards the shape of individual farm systems and therefore farmers, as the "agents of change" (Morris et al., 2000). The CSFs and scenarios show that scale can be important for economic and environmental sustainability. If farmers are to gain access to woodland creation and AES funding sufficient to compensate for the removal of BPS, farm size may have to increase but the trade-off is that farm numbers reduce. When extensive farming is optimal for biodiversity, a trade-off also occurs between biodiversity conservation and consumer and producer surpluses - prices can be higher with smaller quantities of produce available for consumers, unless production declines are offset by SI on more productive land (Desquilbet et al., 2013).

8.5. Conclusions

Here case study farms and land use change scenarios are used to explore how the beef and sheep grazing livestock sector may restructure following the removal of agricultural subsidies and how it can contribute to net zero GHG emission targets. All three scenarios significantly reduced the sector carbon footprint with scenarios 2 and 3 seeing the sector becoming a net carbon sink. Restructuring sees farm size increase as smaller, less efficient farms are incorporated into larger farms. These changes see farmers being displaced from the uplands; some may accept lump sum delinked payments, being made available during transition, and retire, some may leave farming and look for other work, but some may become unemployed. These outcomes will impact on the social structure of upland communities. For viable farms, external inputs significantly decrease as livestock remain outdoors all year round and this, combined with payments from agri-environment schemes and access to woodland creation grants, contributes towards the financial sustainability of the farm. If farmers are able to create a sustainability brand based on compelling product stories, they have the potential to further increase financial security by selling their products at premium prices. Whilst reduced emissions from production and increased carbon sequestration result in net negative GHG emission, extensive practices see the emissions intensities (aka carbon footprints) of the lower production volumes, expressed as CO_2e/kg lwt, increase. The case study farms and scenarios demonstrate that livestock production in the uplands should be considered not only against carbon footprint metrics, but against wider ecosystem services delivery and landscape scale GHG reduction. Future schemes should incentivise and encourage farmers in more productive areas across the UK to adopt sustainable intensification practices whereas viable farmers in Less Favoured Areas must be adequately rewarded for the public goods which they deliver through extensive farming practices.

Acknowledgements

Funding: This work was supported by the FLEXIS (Flexible Integrated Energy Systems) programme, an operation led by Cardiff University, Swansea University and the University of South Wales, and funded through the Welsh European Funding Office (WEFO). The researchers would like to thank the case study participants for the giving of their time to contribute to this study.

Conflict of interest

The authors confirm that there is no conflict of interest with the networks, organisations, and data centres referred to in the paper.

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Chapter 9

Discussion and conclusions

9.1. Introduction

This thesis is concerned with an investigation of the impact of agricultural policy change, on upland farming communities. It began by looking at the current agricultural support payment structure and aimed to assess (a) how the removal of direct subsidies will impact on farming communities, and (b) if payments funding AES deliver high quality public goods. In Chapter 8 it went on to use case study farms to develop scenarios in order to ascertain how farmers within these communities will adapt to change and assist the government in delivering high quality public goods that contribute to achieving net zero carbon targets by 2050. The thesis objectives are met with the findings presented in Chapters 3 to 8. The purpose of this chapter is to summarise the thesis and provide an overview of the strengths of the approach used in this thesis, alongside the possible caveats. These are presented along with a summary of the findings and any implications that these might have for policy-makers, farmers and others. Finally, an assessment of the challenges and uncertainties identified in this thesis that need to be addressed by future research is also provided.

9.2. Discussion of findings

10.2.1. Policy landscape

Chapter 1, the introductory chapter of this thesis, contained a discussion of the background and motivation, research focus and the aims and objectives which provide the context for this study and outline of this thesis. Chapter 2 explained the background and motivations of this study by firstly exploring the challenges to global sustainability and the policies in place to counter those challenges. In these chapters you begin to understand the complexities surrounding sustainability and the delivery of ecosystem services, especially through the use of AES. In 2017, the Utilised Agricultural Area (UAA) in the UK was 17.5 million hectares, covering 72% of land in the UK and there were 217 thousand agricultural holdings with an average area/holding of 81.4 hectares (Defra; DAERA; Welsh Assembly Government and the Scottish Government, 2018). If the UK and the devolved governments are to deliver on environmental targets and reach Net Zero Carbon GHG emissions by 2050 they will need the cooperation of farmers and landowners who must be seen, not only as stakeholders, but as the primary delivery mechanism without which, all attempts to become carbon neutral are likely to fail. Chapters 3 to 8 are the experimental chapters, which are used to show how the social, economic and environment pillars of sustainability interlink to create opportunities, or barriers, to the delivery of public goods through AES.

10.2.2. Economic impact of agricultural policy change

Chapter 3 delivers on objective 1 of the thesis aims by exploring the economic impact of agricultural policy change post-Brexit. The June Survey of Agriculture (Defra; DAERA; Welsh Assembly Government and The Scottish Government, 2018) or the results of the Farm Business Survey (Defra, 2017) are often used to show current farm business incomes (Grant, 2016; Swinbank, 2017; Hubbard et al., 2018) and to show how the introduction of tariffs or a lack of trade deals will impact upon the farmer. However, variation in payments exists between, and within farm types (Defra, 2017; Welsh Government, 2017a), making it difficult to predict the number of farms likely to be impacted by the removal of Pillar 1 subsidies using just FBS/FBI average farm incomes. This study does not consider the impact of a no trade deal on farming sectors as there are numerous studies contributing to the literature surrounding an EU exit under various trade scenarios (Feng et al., 2017: Dwyer, 2018; Hubbard et al., 2018; Shrestha et al., 2018). Instead, it uses an analysis of the WSO dataset, combining SO and BFP through the use of CPH numbers, to eliminate of some of the variation surrounding average Pillar 1 payments. It goes on to show the potential impact of subsidy removal on farms, even if there is no change to current trade regulations. The chapter shows it is likely that ca. 34% of Welsh farmers, the majority being grazing livestock farmers in SDA and DA areas, will struggle to remain viable should Pillar 1 direct payments be removed and not be replaced by an alternative income source delivering similar amounts. The findings of this study support Barnes et al. (2016), Baldock et al. (2017) and Dwyer (2018) agreeing that SDA and DA sheep and cattle farmers are most likely to consider an exit strategy, potentially releasing agricultural land to the open market which, in some areas, may lead to an increase in "ranching" as a way of managing land and stock, with control of the land shifting to the control of fewer farmers with larger farms. This will undoubtedly have an impact on some farming communities but not all farmers think this is a bad thing. This study uses the chapters to explore attitudes towards subsidies, now and post-Brexit (Chapter 6), attitudes towards AES (Chapter 5) and explore how levels of social capital may hinder or enhance a farmer's willingness to embrace future agricultural policy (Chapter 7).

10.2.3. Adapting to agricultural policy change

In addressing objective 4 of the thesis aims, Chapter 6 shows that many farmers believe that they able are to evolve and adapt, enabling them to respond to new challenges as they arise. An exit from the EU may bring economic, social and environmental uncertainty but farmers have always had to cope with uncertainty, especially regarding weather patterns, prices and policy change (Urry, 2005; Franks, 2006; Darnhofer et al., 2010) and this is unlikely to be seen by many as being any different to previous challenges. The chapter findings show that young farmers <35 are more likely than those >65 to believe that direct subsidies encourage inefficiencies, supporting the findings of Urdiales et al. (2016), who found younger farmers to be more eco-efficient on the farm. Overall, 50% of respondents believe direct subsidy payments support inefficiency in farming which supports previous studies which show direct subsidy payments negatively affecting farmers' effort and hence on their technical efficiency (Gailhard and Bojnec, 2015; Minviel and Latruffe, 2017), and show farmers have fewer incentives to efficiently work the land when they receive government subsidies (Serra et al., 2008).

Chapter 3 shows that ca. 44% of the sampled agricultural land is on holdings potentially facing financial hardship, therefore farmers and landowners will have to make decisions that impact upon farm survivability. The chapter explores opportunities to implement a more balanced approach to land management, based on sustainable intensification and land sparing principles that could support governmental visions (Defra, 2018; Welsh Government, 2018; Welsh Government, 2019) to keep farmers on the land, improve productivity and provide environmental benefits. Findings support the Welsh Government’s Sustainable Land Management approach (Welsh Government, 2019) as means to reduce risk and deliver social and ecological benefits. However, given the size of the challenge, one must question whether funding levels, post-Brexit, will sufficiently mitigate against all the social and ecological risks identified in this paper. This potential need to adapt and embrace new farming practices links to Chapter 5 where it is demonstrated that because the decision-making process, surrounding participation in AES, is complex a deep understanding of people's perceptions, attitudes and behaviour is needed. Whilst Chapter 6 looks at attitudes to subsidies and agricultural policy change, Chapter 5 explores perceptions and behaviours relating to AES and delivers on objective 3 by identifying barriers and opportunities to the uptake of AES.

10.2.4. Attitudes to AES

In Chapter 5, in-depth interviews conducted with farmers, confirmed the findings of other studies (Morris and Potter, 1995; Falconer, 2000; Van Herzele et al., 2013), which show that the farmer’s decision to participate, or not, in AES is influenced, not by an individual factor, but by a complex mix of personal, family and farm business factors. The results show that the structure of the CSS significantly increased private transaction costs for farmers and this in turn has led to an exodus of farmers from AES. ‘Active adopters’ (Morris and Potter, 1995) and ‘forward thinkers’ are prepared to overcome barriers to uptake, persisting with scheme delivery even when transaction costs are high, and their experiences of CSS are negative.

However, findings support Kovács (2015) who found farmers to have a fear of the state as a result of their past experience of the audit process which increased financial risk through the enforcement of administrative rules that appear to many farmers as irrelevant to the practice of agriculture. Farmers reflect on previous experiences of local AES run by NPA's and argue that the primary means of reducing TCs and overcoming barriers to the uptake of CSS would be to return the management and administration responsibilities for AES to a local level, in this case the NPA. The findings concur with those of Mettepenningen and Van Huylenbroeck (2009) who suggest that the more decentralised a policy is, the lower the private TCs will be, due to a reduction in the paperwork. This links back to Chapter 3 where the study supports Marsden et al. (2015) who also identify the need for a more cohesive and integrated approach to sustainable land management across the protected landscapes of Wales (Areas of Outstanding Natural Beauty and National Parks), if the government is to effectively resolve the more complex issues currently facing rural areas of Wales.

In Chapter 5, four primary themes as motivations for entering CSS are identified, namely, goodness of fit, financial, environmental and forward thinking. 'Goodness of Fit', i.e., how well a scheme fits with existing farm-management plans, is seen as a motivator for those transitioning to CSS and as a barrier to entry for those who have never or have previously been in AES. This directly links back to the findings of Chapter 4 which delivers on objective 2 demonstrating that the prescription options-based approach adopted by the Glastir AES leads to the misplacement of options, a duplication of funding within land parcels, and payments for 'business as usual' options that requires minimum change to farming practice. Agreeing with Davey et al. (2010) and de Krom (2017) the results show that whilst this approach maintains a status quo, and stops further intensification and nutrient overload, it is unlikely, through current scheme design, to significantly improve biodiversity at a landscape level, or promote long-term behavioural change. The current AES structure is used by UK governments as a tool to assist in meeting environmental targets but the prescriptive nature of this type of scheme is often seen as a barrier to scheme uptake and long-term behavioural change (Wilson and Hart, 2000; de Snoo et al., 2013) which matches the findings in Chapter 5. In addition, the cost-effectiveness (Ansell et al., 2016), and ecological impact of this type of 'action based' AES is also widely debated in the literature (Kleijn and Sutherland, 2003; Kleijn et al., 2006; Fuentes-Montemayor et al., 2011a, b; Princé et al., 2012; Sabatier et al., 2012; Wilkinson et al., 2012; Ekroos et al., 2014; Wood et al., 2015; Caro et al., 2016; McHugh et al., 2016). It is therefore argued that current AES are more effective at delivering income support to ensure community and cultural cohesion and the viability of predominantly upland farming lifestyles than ecosystem services and that that the ‘one size fits all’ approach to AES currently taken by AES policymakers blocks some from participation and that the complexity of the scheme isolates the farmers from the scheme provider.

10.2.5. Social capital and farming communities

Chapters 5 and 6 present individual attitudes and perceptions of AES, Brexit and subsidy provision but social capital, together with human and physical capital, is increasingly acknowledged to be of critical importance in farmers’ decision-making (Mathijs, 2003; Mansfield, 2018). Chapter 7 delivers on objective 5 and contributes to current literature through the use of a series of interviews with UK farmers across differing locations and categories to ascertain how levels of social capital may hinder or enhance a farmer’s willingness to embrace future agricultural policy. Results found farmers in the non-AES and AES groups to be traditional thinkers with high levels of bonding capital. Agreeing with Tregear and Cooper (2016), the study shows that whilst this brings them together as a farming community it also creates barriers to interaction with people and groups outside of the immediate network. In contrast, the HNVF group were found to have the most diverse range of groups with membership of agricultural groups being the lowest, and membership of non-agricultural and political groups being higher than both the AES and non-AES groups agreeing with Cofré-Bravo et al. (2019) that this indicates high levels of bridging and linking capital within this group. Findings support Potapchuk et al. (1998), and more recently Mansfield (2019), by showing that to ensure the viability of rural communities, both the government and farmers have a role to play in building the social capital that will gain them access to wider networks, specialised knowledge and experience and funding and training. If farmers are to increase level of bridging and linking social capital, they will have to move out of their comfort zone and engage with networks outside of their own. Governments must shift from acting as controller, regulator, and provider to new roles as catalyst, convener, and facilitator. Farmers and scheme providers must look to build closer relationships with each other to ensure farmers gain the knowledge and experience required to access future public goods schemes that can provide them with additional financial support and deliver on environmental and climate change targets.

10.2.6. The future of farming in the uplands and the potential for carbon offsetting

Chapter 3 highlights the fact that the current payment support system will cease to exist and farmers and land managers will in future be offered payments for the delivery of "public goods", such as better air and water quality, improved soil health, higher animal welfare standards, public access to the countryside and measures to reduce flooding. It shows that potential adaptive pathways include: increasing intensity or expanding present agricultural activity (Bartolini, and Viaggi, 2013; Latruffe et al., 2013), extensification and a shift to high nature value farming or AES (WRO, 2011; Bowman and Zilberman, 2013; Ribeiro et al., 2014), the diversification of agricultural and non-agricultural activities (McNally, 2001; Lobley and Potter, 2004; Weltin et al., 2017) or withdrawal from agricultural or land based activity (Raggi et al., 2013). Chapter 6 shows that 64% of interviewed farmers were prepared to do whatever is necessary to secure their land for future generations and 58% prepared to change the way they farm with 44% agreeing that they would be prepared to shift from food production to farming for public goods if it ensured farm viability. Chapter 3 shows 34% of Welsh farmers facing financial difficulty following an EU departure and in Chapter 6, 46% agreeing that they would leave farming if they could not produce food. The findings from Chapters 3, 6 and 8 are used to support objective 6, and agreeing with Wallace and Scott (2017); Dwyer (2018) and Shrestha et al. (2018), Chapter 8 restructures the grazing livestock sector to take account of land becoming available due to departures from the sector. This then expands upon the pathways described in Chapter 3 through the use of scenarios which explore viable upland farming systems compatible with net zero carbon targets by 2050 (CCC, 2019; 2020). Under current economic conditions, there is a severe lack of profitability in sheep enterprises due to increased input costs, poor lamb prices and increased disease risk (Thompson, 2009; Dwyer, 2018) and following an exit from the EU there is likely to be a consequent reduction in sheep and shepherd numbers on the hills. In Chapter 8, all CS farmers had significantly reduced sheep numbers following an audit of farm income which revealed the sheep enterprise, at its then scale, to be a net drain on financial resources. In this chapter, all scenarios see a significant drop in sheep numbers across the sector leading to a large-scale displacement of livestock, some of which can be accounted for in a drop in consumption patterns due to changing habits (CCC, 2020) but the remainder would need to be accounted for through an increase to high level stocking rates (AHDB, 2016) and an increase in dry matter yield through the sustainable intensification of lowland grasslands (Qi et al., 2008). This decrease in sheep stocking number and a move towards traditional, hardy cattle breeds, which are grazed only on the farm's naturally available grass (i.e., without artificial fertilisers), increased profit (or reduces losses), through significant savings of variable costs on CS 1 and 2 farms.

This redistribution of livestock takes a 'land sparing' approach to land management in the uplands which is described as maximising the productivity of farmed land so that land elsewhere can be protected from agricultural expansion or restored to natural habitat (Balmford et al., 2015) and a 'land sharing' approach in the Other grazing areas which involves the sustainable management of the food production landscape in a way which is sympathetic to wildlife, promoting on-farm biodiversity (Balmford et al., 2015) and, in the case of these scenarios, agroforestry. All of these scenarios significantly reducing the total GHG emissions (kt CO_2e) from farming and land use and an increase in kt CO_2e sequestered in forestry to the point that under scenarios 2 and 3 the grazing livestock sector becomes a significant carbon sink. Lower stocking rates and more extensive fattening translate to less efficient production led to an increase in kg CO_2e/kg lwt for both the beef and sheep sectors in the SDA/DA grazing sector compared to the average SDA/DA baseline emissions. Total kg CO_2e/kg lwt/wool increases in the more extensive SDA grazing sector but this is offset by the removal of cattle from the DA grazing sector and more efficient practices in the 'Other' grazing sector. However, the extensive nature of farming under these scenarios also allows for the restoration of the uplands, managing them for biodiversity, carbon, water, flood risk and recreational benefits which contribute to achieving future environmental targets (WG, 2015; Defra, 2018; CCC, 2019; CCC, 2020). There is also potential for restoration on some 60% of the Welsh deep ($\geq$0.5 m) peat resource that occurs within the mountain, moorland and heath habitat suite (NRW, 2016).

10.2.7. Challenges to change

However, as shown in Chapters 4 and 5, the current structure of AES can present barriers to uptake. Evidence to date shows that there are advantages to the results-based approach not found in management-based schemes with similar objectives, dealing with environmental efficiency, farmers' participation and development of local biodiversity-based projects (Herzon et al., 2018), but there can be challenges, including: scientific uncertainty; pricing of ecosystem services; timing of payments; increased risk to land managers; compliance with World Trade

Organisation regulations; and barriers to cross-boundary collaboration in the management of ecosystem services at habitat, catchment or landscape scales (Reed et al., 2014). In addition, farmers must ‘buy in’ to future schemes, they must, as shown in Chapter 5, see the benefits to their business if they are to embrace new approaches, these benefits may be financial i.e., funds to replace BPS income, or they can be to the farm (see Chapter 5) or to themselves through an increase in social capital (see Chapter 7). As shown in Chapter 7, government agencies can enhance the potential for farmers to embrace scenarios such as those shown in Chapter 8 and increase the likelihood of meeting environmental targets by building relationships, advising mentoring and mediating within rural communities to increase the building and linking capitals that will enable these communities to develop new ideas and increase sustainability.

In conclusion, the experimental chapters in this study interlink to explore agricultural policy change and the future of sustainable farming in the uplands. It is highly unlikely that the structure of farming in the uplands will remain the same post-Brexit. Therefore, farmers will have to adapt and change if they are to gain access to funding which secure farm viability. In contrast, governments need farmers and landowners, not as stakeholders but as the primary delivery mechanism for public goods, without which it is unlikely they will meet carbon reduction, biodiversity and tree planting targets by 2050.

9.3. Limitations of the present study

The approach undertaken in this thesis enabled us to make a holistic appraisal of the challenges facing upland farmers and policy-makers as the UK moves from direct subsidy support to a ‘public money for public goods’ approach to providing financial support to farming communities. In the experimental chapters, steps are taken to reduce the limiting factors are shown, however, there are factors remaining that must be taken into consideration.

The dataset sourced from the Welsh government and used in Chapters 3 and 8, excluded data on common land. Because of this the decision was made to focus on upland farms without commons. Two of the farms used as case study farms had commons right but no longer exercised them. Some of the farmers interviewed for chapters 5 and 7 had commons rights and were involved in collaborative agri-environment schemes on the commons but the focus of the interviews revolved around on farm-schemes and income.

In chapter 3, the dataset used contains information derived from the June Agricultural Survey (WG, 2017b). The data, apart from cattle, are estimates based on a sample survey of farms. The WSO states the main quality issues with the survey include the following:

- Sample size. The sample is a relatively large share of the all farms in Wales. The sample is stratified so that larger farms are sampled more frequently than smaller ones.
- Farm registration. There is no compulsory register of farms in the UK. The registrations in place will cover the main commercial farms very well. The problem is to identify smaller farms that may not be commercially focused. While this will affect estimates of the number of farms, analysis has shown that it has limited impact on the estimates of total areas of land or livestock data.
- Non-response. Falling response rates are an issue for the survey, as with many other government surveys. This is a particular issue because certain farm types and sizes appear to be more or less likely to respond to the form. Non-response is a particular issue when a variable is dominated by a very small number of particularly large farms. Examples are poultry, pigs, horticulture and some of the smaller crop’s types. It also impacts on the range of any confidence interval and the percentage of the estimate that actually comes from responses.
- Mis-response. At the level of recording if land is grass or a crop or which species an animal is there is limited scope for mis-response. There is more scope for error in the

subcategories, particularly in reporting the difference between breeding animals and others. As already stated earlier it appears that there may be an issue of mis-response for some of the questions on farm labour.

- Sampling error. Any sample survey will be subject to sampling error as the survey responses are taken and estimates are made to determine what this means in terms of all farms in Wales.
- Consistency over time. The questions that ask the farmers have been largely consistent since the last major re-design in 1998. Changes since then have largely been restricted to cosmetic changes to the form and changes to wording and guidance.
- Cattle data. Since the cattle data are taken from the registration of animals with the Cattle Tracing Service the quality issues are rather different. The cattle results are not affected by sampling or response issues. As with any administrative system the coverage will not be entirely perfect but it is extremely good.

Data collected for chapter 5 contributed to a report compiled by the NYMNPA as part of the Defra ELMS tests and trials in the area. This limited the scope of the research area to farms within the North York Moors National Park. Most participating farmers had previously engaged with and had given permission to be contacted in the future. Farmers directly contacted by the researchers were then asked to recruit other farmers in their network through snowball sampling techniques. Snowball sampling was also used to recruit participants for Chapter 7. This may introduce some levels of bias and it is therefore recommended that future research projects consider using sample areas across a wider geographic area and potentially recruit where possible through government mailing lists, farmers unions or at farmer's markets. This may in some cases incur costs which may add additional limiting factors.

Sample size and funding was also a limiting factor in data collection for Chapter 6. There was potential to obtain large mailing lists from the UK and Welsh agricultural statistics offices but the data within these lists contained postal addresses and funding limited the ability to use this recruitment method.

9.4. Recommendations for future study

Studies presented in this thesis have provided pivotal information about the complexities surrounding the social, economic and environmental sustainability of upland farming and its contribution towards Net-zero GHG emission targets. However, several research gaps have also been identified during the work. It is clear from the results presented here that a much deeper analysis of many areas covered in this project are required. Some of these are detailed below:

10.4.1. The impact of BPS removal

In Chapter 3, the Welsh Agricultural Statistics Office was able to provide a dataset which combined June Agricultural data with data on BPS payments and this enabled the analysis of Welsh farmers. Further research is required to measure the impact UK-wide and similarities in the payments structures suggests there is potential to extend this strategy across areas of England, Scotland, and Northern Ireland with similar demographics of farm typologies. This would however require cooperation from the agricultural statistics offices across these nations.

The survey conducted in Chapter 6 was very restricted, with a small sample size. A more compressive fully-funded survey could further identify farmers' attitudes towards agricultural subsidies and policy change and identify potential pathways post-Brexit.

10.4.2. The decentralisation of AES policy

Both Chapters 3 and 5 discuss the potential benefits of decentralising AES policy to a NPA level with the NPAs playing a more central role working with farmers and the government to improve the condition of the protected landscapes and deliver high quality, targeted, 'public goods' at a landscape level. More research is required to assess the willingness of farmers to work alongside NPAs in return for payments to maintain environmental, cultural and spiritual ecosystem services.

Larner and Craig (2005) show that in New Zealand pure neoliberalism has been replaced by a new form of joined up, inclusive governance characterised by relationships of collaboration, trust and, above all, partnership. Can this be achieved by further decentralisation of governance to a more local level, is there scope, and a desire to do so and in doing so would it increase the likelihood of farmers participating in schemes which deliver public goods for public money?

10.4.3. Clarity of AES objectives

Chapter 4 found that current prescriptive schemes are often delivering management options in a vacuum with no overarching impact assessment or measurable outcomes identified. This leads to the misplacement of options, a duplication of funding within land parcels, and payments for 'business as usual' options that deliver no environmental change. Further research is required to create pathways from target to delivery for example, if the target is Net-Zero GHG emissions then clear objectives must be created for each sector and farmers and landowners who are must be clear on the objectives and what is required to achieve them.

10.4.4. The effectiveness of results-based AES

In 2016, Natural England and the Yorkshire Dales National Park Authority began a results-based AES pilot, funded by the EU. In 2018, the pilot was extended for 2 more years with funding from Defra. This type of scheme presents an opportunity to expand upon some of the knowledge gaps identified in this study.

- Do farmers in this type of scheme feel a sense of ownership and responsibility? Do they feel as if they are in a partnership with the NPA and Natural England or do they still feel that they are just doing what they are told?

- Are farmers in this type of scheme more prepared that those in prescriptive schemes to participate in the delivery of options that may not necessarily have goodness of fit to their current farming practice?
- Have levels of bridging capital increased as a result of closer interactions with the NPA, Natural England, habitat advisors and other farmers within the scheme?
- What are current relationships like between NPAs and farming communities?
- How would farmers in this type of scheme feel about AES policy being devolved to a NPA level and what do they think the advantages and disadvantages of doing so would mean?
- The current pilot scheme involves a relatively small number of farmers. What would other farmers feel about involvement in this type of scheme and what do they think the advantages and disadvantages of doing so would be?

10.4.5. The environmental impact of farmers leaving AES

Chapter 5 found large numbers of farmers leaving the CSS. When farmers leave AES what changes do, they make to farming practice and what impact does that have on the environment?

10.4.6. How can relationships within and without rural communities be improved to ensure foster sustainable practices

Chapter 7 identified the need to increase bridging and linking capital. How can governments, NPAs and NGOs work improve relationships with rural communities in order to foster a cooperative spirit which will insure the sustainability of farming and wider rural communities?

What are ‘incomer’ perceptions of the environment and of farming communities, and what do they think needs to be done to make the land use sector a net carbon sink?

What can be done to foster better relationships between farmers and the wider rural community, and by doing so, will it increase building and linking capital?

10.4.7. What impact will land use change have on tenant farmers?

England and the Devolved Administrations have an ambition to increase woodland creation, which if achieved, would deliver annual planting of 20,000 hectares by 2020, and 27,000 hectares from 2025. Will tenant farmers be the trade-off for trees, how many tenant farms are being taken back in hand and what is that land being used for?

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Appendix 1

Supplementary material for Chapter 4

What can management option uptake tell us about ecosystem services delivery through agri-environment schemes?

David Arnott, David Chadwick, Ian Harris, Aleksandra Koj, David L. Jones

1. **Structure.**

Glastir pays for the delivery of specific environmental goods and services aimed at:

- Combating climate change.
- Improving water management.
- Maintaining and enhancing biodiversity.

2. **Glastir Advanced - scheme closed to new entrants.**

Glastir Advanced is a five-year whole farm sustainable land management commitment designed to deliver the following environmental aims:

- Reducing carbon and greenhouse gas emissions.
- Adapting to climate change and building greater resilience into farm businesses.
- Managing our water resources to improve water quality and reduce flood risks.
- Contributing to economic sustainability of farms and the wider rural community.
- Protecting the landscape and the historic environment while improving access.
- Contributing towards a reversal in the decline of Wales' native biodiversity.

3. **Glastir Commons - scheme closed to new entrants.**

Common land forms an important element of the farming tradition in Wales, particularly as a grazing resource.

It also plays a key role in the management of habitats and the Welsh landscape.

3.1. Options

There were two options under Glastir Commons:

- A closed period of 3 continuous months in a 5-month period between November and March, or
- Minimum and maximum stocking densities tailored to each common with monthly diaries kept to record the movement of stock.

4. Glastir Efficiency Grants - scheme closed to new entrants.

A capital grant scheme aimed at improving resource and business efficiency, and reducing the carbon equivalent emissions of agricultural and horticultural holdings.

5. Glastir Entry - scheme closed to new applicants.

Glastir Entry was a whole farm, land management scheme open to all farmers and land managers throughout Wales. Successful applicants made a commitment to deliver environmental goods for five years under a legally binding contract.

5.1. The All-Wales Element was comprised of 3 main components:

- Cross compliance - a set of compulsory requirements applied to all your agricultural land.
- The Whole Farm Code (WFC) - this applied to all the land entered into the contract
- Management options - you were able to select from a range of options that were best suited to your farm. A minimum number of options were required in order to reach your points threshold.

6. Glastir Organic - scheme closed to new entrants.

Glastir Organic was an element of the Welsh Government's Glastir Scheme. Glastir Organic provided support to organic farmers and producers, who delivered positive environmental land management.

6.1. Glastir Organic was a 5-year contract with Welsh Government, open to:

- Those who wished to convert to organic production.
- Existing organic producers who met the eligibility criteria.

7. Glastir Small Grants.

Land Managers and Farming Businesses across Wales have an opportunity to apply for Capital Works under the Glastir Small Grants Scheme.

This stand-alone scheme contributes to the delivery of Welsh Government's ambitions to tackle climate change, improve water management, restore traditional landscape features and enhance habitat linkage for pollinators.

7.1. There are three themes under Glastir Small Grants:

- Carbon – aid the delivery of Welsh Government's ambitions to increase carbon sequestration.
- Water - improve water quality and reduce the risk of flooding.
- Landscape and Pollinators - maintain the traditional landscape features in Wales, and provide habitat linkage for pollinating insects.

8. Glastir Woodland Creation.

Glastir Woodland Creation provides financial support for new planting. Financial support is also available for planting trees in areas that continue to be grazed as part of an agroforestry system i.e., combining agriculture and forestry.

9. Glastir Woodland Restoration.

Funding is available to replant areas of larch that have been felled to help prevent the spread of *Phytophthora ramorum* disease affecting the trees.

The area eligible for funding under Glastir Woodland Restoration will be equivalent to twice the area of larch identified on the Statutory Plant Health Notice or felling licence. For example, if 1 hectare of larch is shown on your felling licence, the maximum area eligible for funding under Glastir Restoration will be 2 hectares.

10. Post code areas.

The HR postcode district was excluded for the purpose of this research as it size, and location on the Wales/England border, makes it difficult to distinguish between payments being made to Welsh farmers with land in England or English Farmers with land in Wales.

11. Land Parcel Identification System (LPIS).

An IT system based on photographs of agricultural parcels used to check payments made under the Common Agricultural Policy (CAP).

12. Generalised Description of the Agricultural Land Classification Grades Grade and standard colour notations Description of agricultural land Detail (WG, 2017e).

Grade 1: Excellent quality No or very minor limitations on agricultural use. Wide range of agricultural and horticultural crops can be grown. High yielding and consistent.

Grade 2: Very good Minor Limitations on crop yield, cultivations or harvesting. Wide range of crops but limitations on demanding crops (e.g., winter harvested veg). Yield high but lower than Grade 1.

Grade 3: (subdivided) Good to moderate: Moderate limitations on crop choice, timing and type of cultivation, harvesting or level of yield. Yields lower and more variable than Grade 2.

Grade 3a: Good Moderate to high yields of narrow range of arable crops (e.g., cereals), or moderate yields of grass, oilseed rape, potatoes, sugar beet and less demanding horticultural crops. 3b Moderate: Moderate yields of cereals, grass and lower yields other crops. High yields of grass for grazing/ harvesting.

Grade 4: Poor Severe limitations which restrict range and/or level of yields. Mostly grass and occasional arable (cereals and forage), but highly variable yields. Very droughty arable land included.

Grade 5: Very poor Severe limitations which restrict use to permanent pasture or rough grazing except for pioneering forage crops.

Appendix B: The breakdown of Glastir management categories (RPA, 2017)

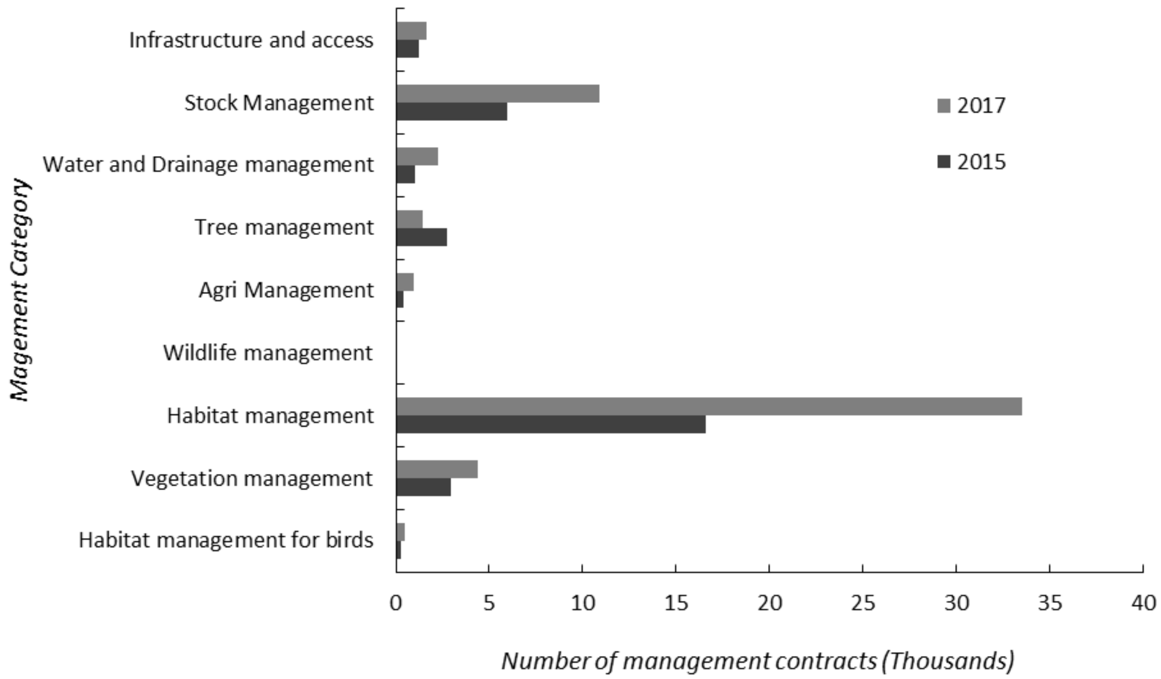


Figure B.1. Total GA management contracts by management categories for 2015 and 2017 (RPA, 2017).

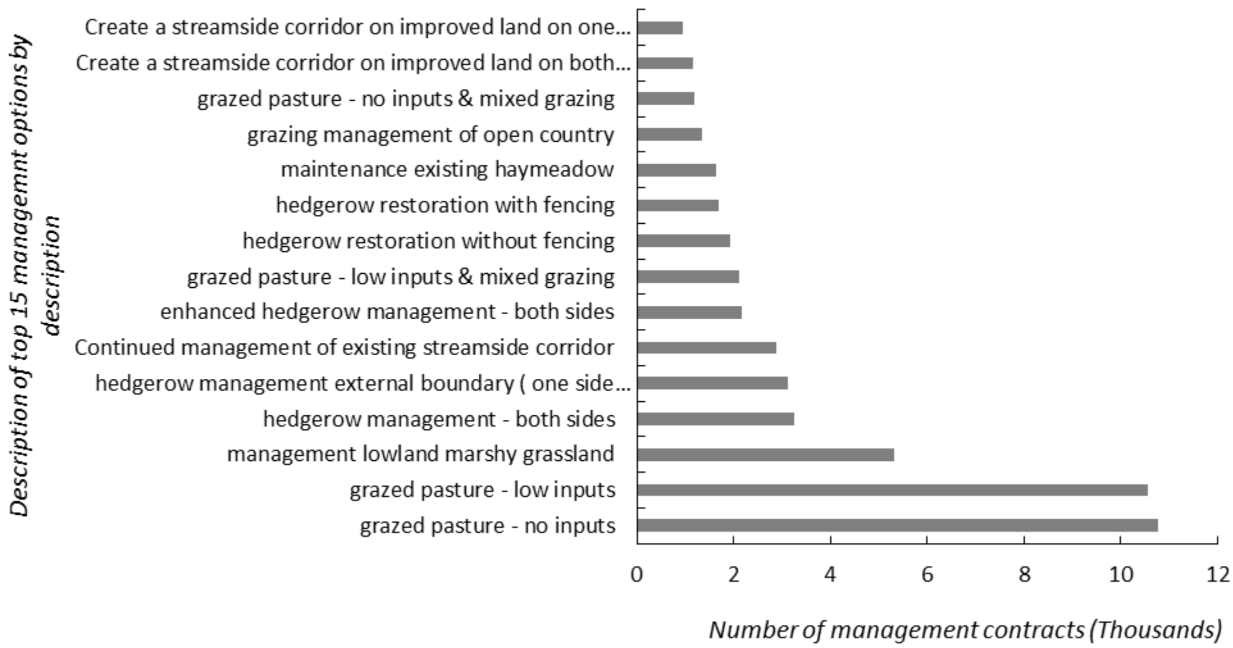


Figure B.2. Top 15 GE management options for 2015 by number of management contracts (RPA, 2017).

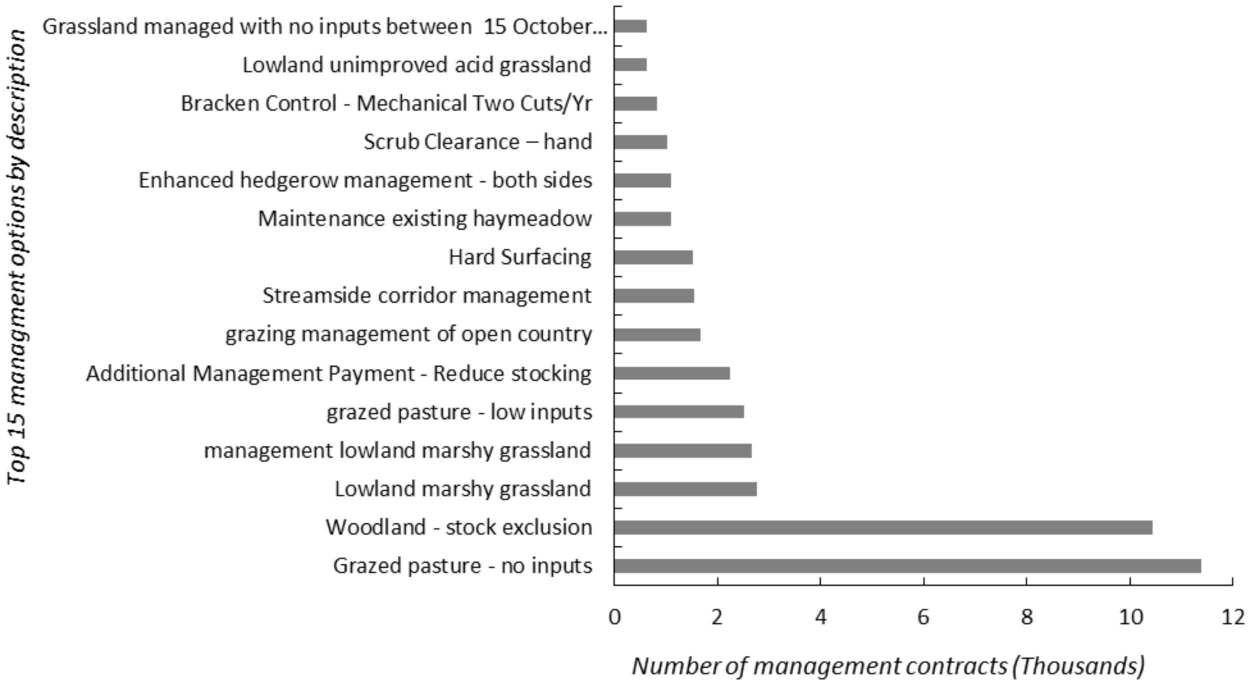


Figure B.32. Top 15 GA management options for 2017 by number of management contracts (RPA, 2017).

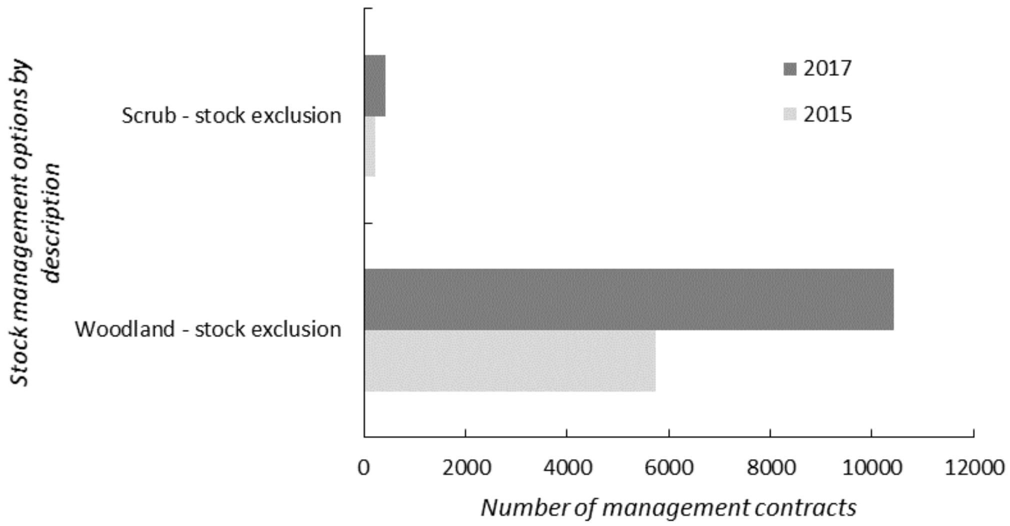


Figure B.4. GA stock management options for 2015 and 2017 by number of management contracts (RPA, 2017).

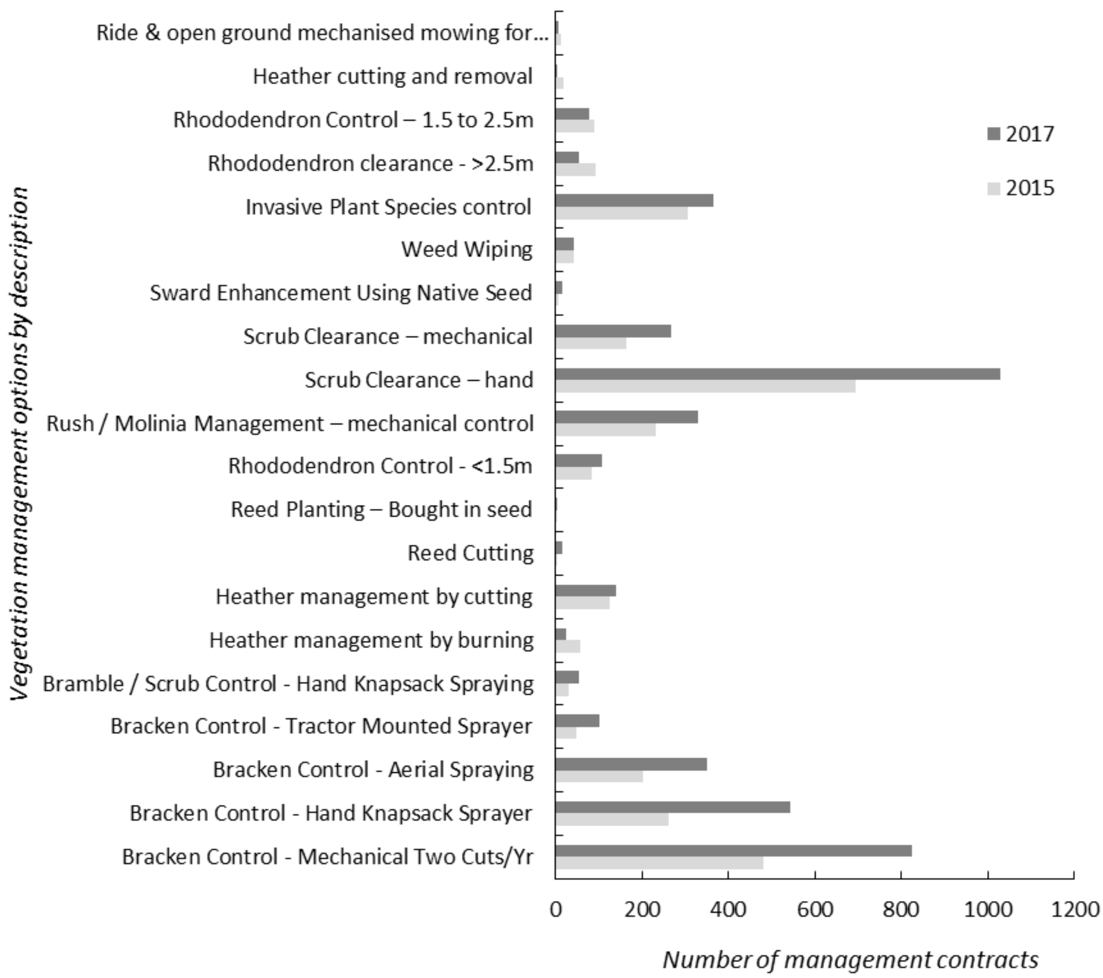


Figure B.53. GA vegetation management options for 2015 and 2017 by number of contracts (RPA, 2017).

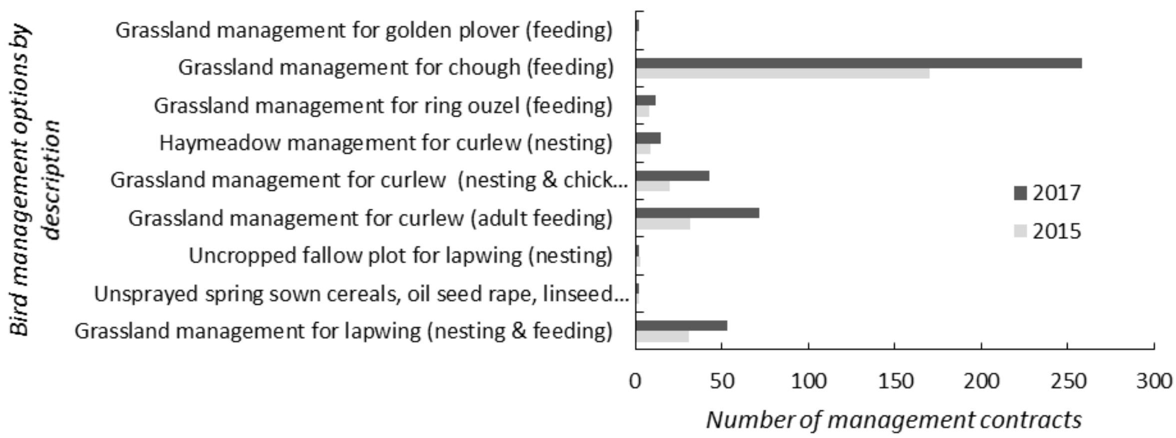


Figure B.6. GA bird management options for 2015 and 2017 by number of contracts (RPA, 2017).

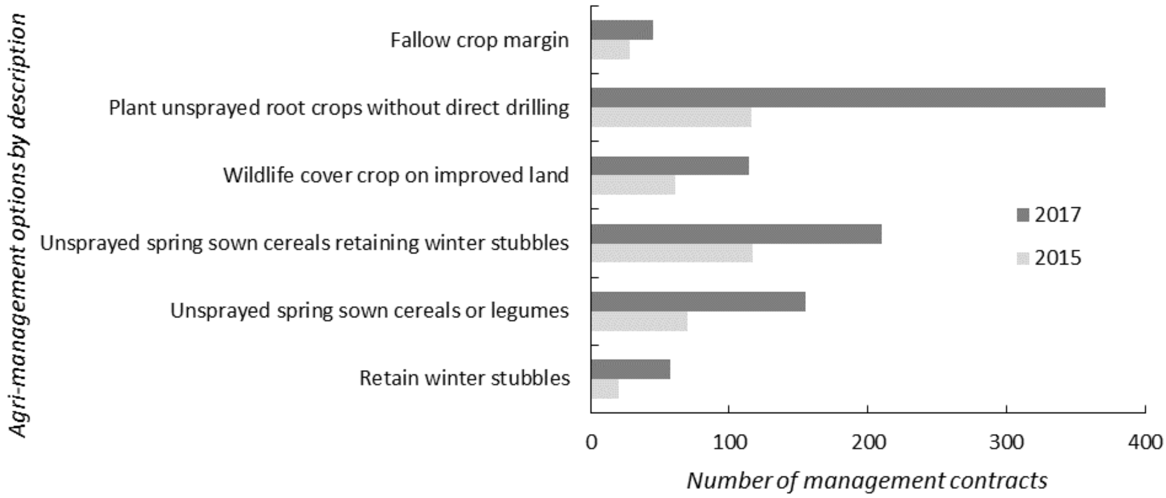


Figure B.7. GA agri-management options for 2015 and 2017 by number of contracts (RPA, 2017).

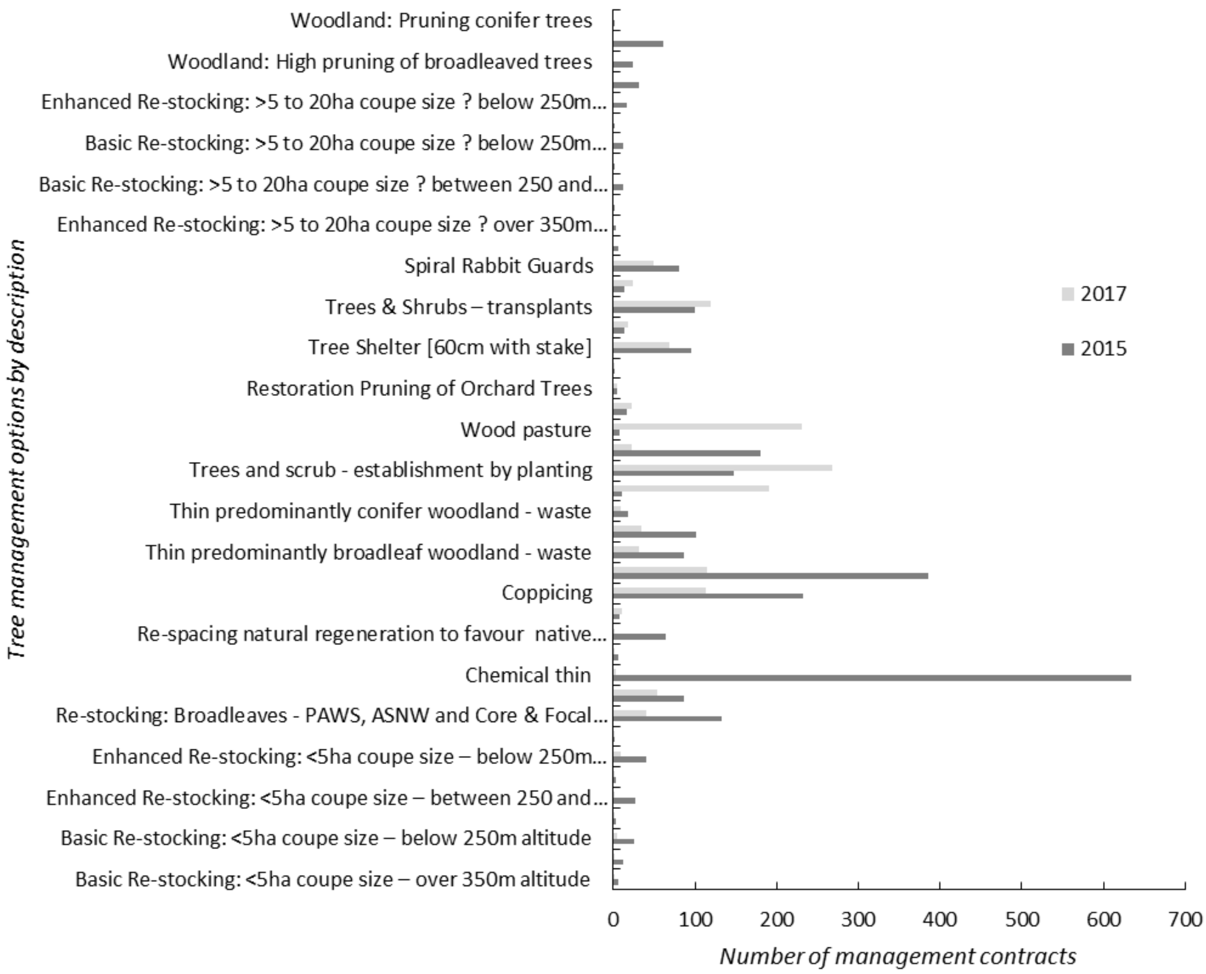


Figure B.8. GA tree management options for 2015 and 2017 by number of management contracts (RPA, 2017).

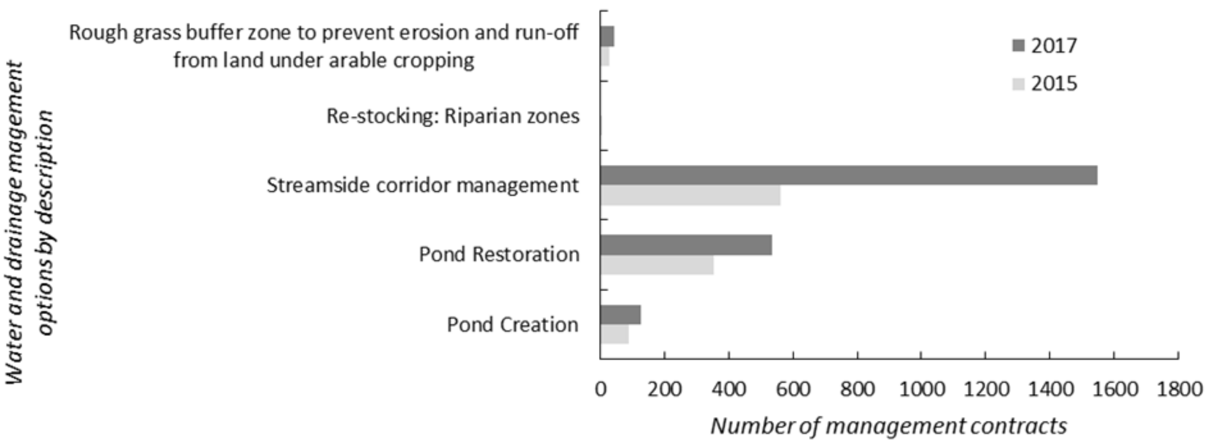


Figure B.9. GA water and drainage management options for 2015 and 2017 by number of management contracts (RPA, 2017).

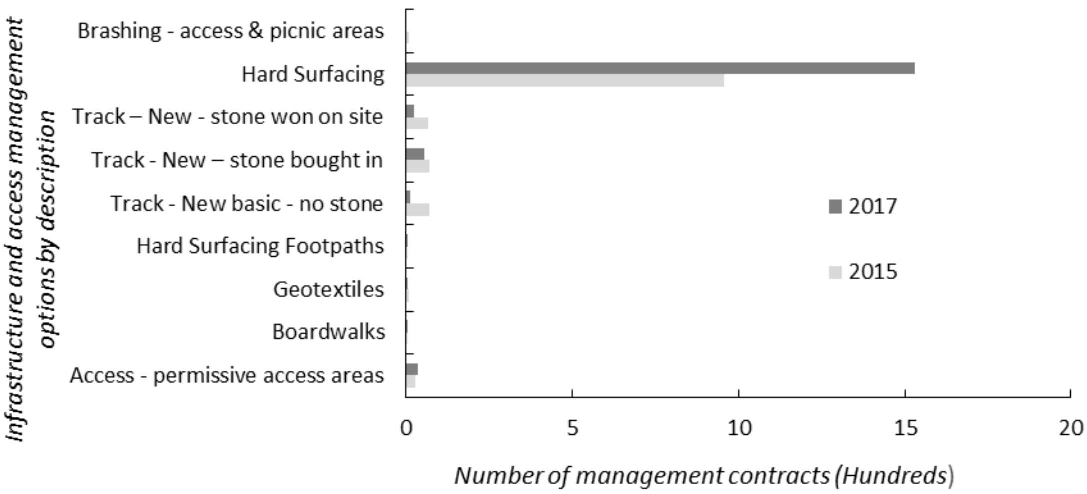


Figure B.40. GA infrastructure and access management options for 2015 and 2017 by number of management contracts (RPA, 2017).

Appendix C: Allocation of CAP spending

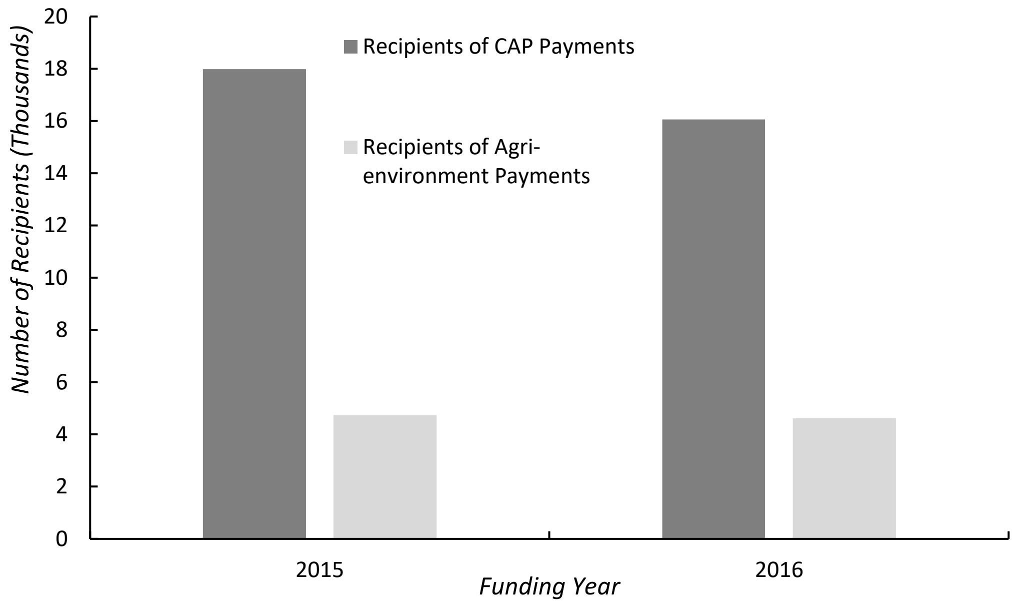


Figure C.5. Number of recipients of CAP payment (Pillar 1 and Pillar 2) and the number of recipients receiving AES payments for 2015 and 2016 (DEFRA, 2017)

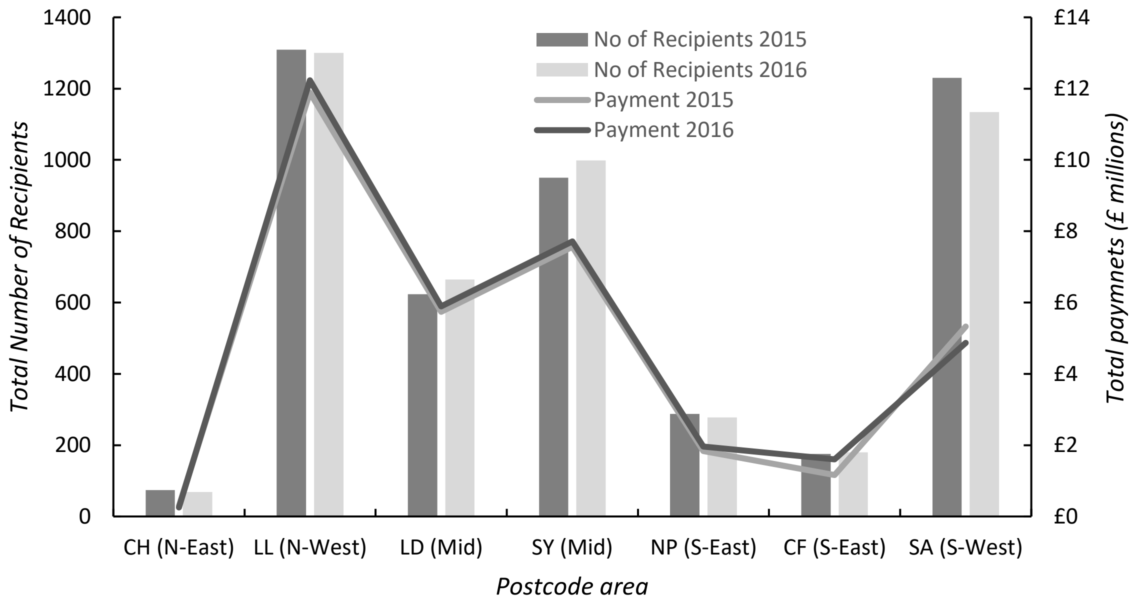


Figure C.2. Distribution of AES payments and recipients across the post code areas and regions of wales. Postcode areas identify the primary town or city in the region.

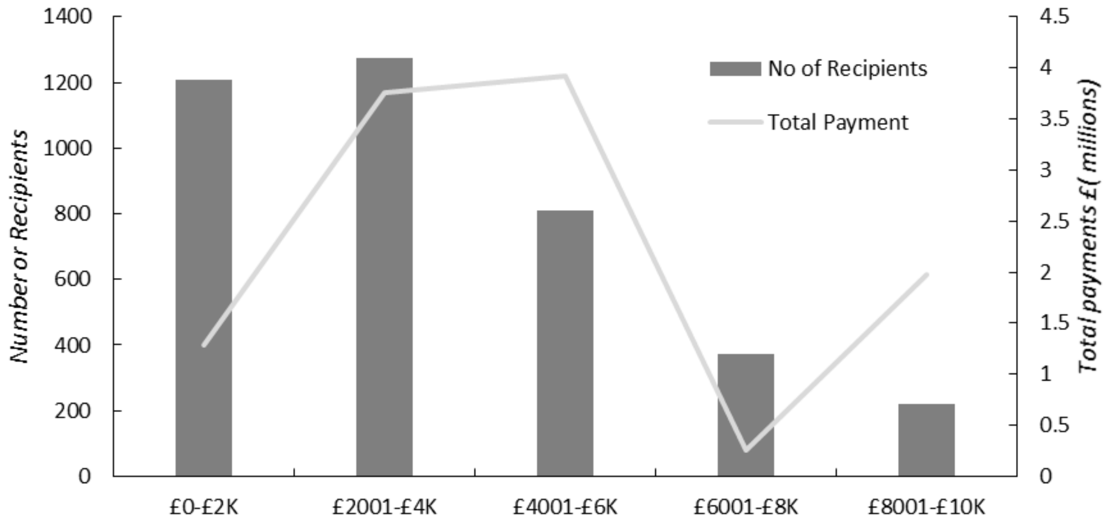


Figure C.3. Distribution of 2016 AES payments showing the total number of recipients and the total payments received across the £0-10K payment range. (DEFRA, 2017).

Table C.2. GA management option descriptions. The table shows the option number and the total number of management contracts awarded by year (Option count) (RPA, 2017).

Description	Option Number	Option count 2017	Option Number	Option count 2015
Enhanced hedgerow management - both sides	5	1095	5	287
grazed pasture - no inputs	15	11391	15	4583
Management lowland marshy grassland	19	2657	19	1133

Management lowland and coastal heath	20	89	20	64
Management grazed saltmarsh	21	66	21	21
Maintenance existing hay meadow	22	1098	22	448
Management of sand dunes	25	28	25	11
Fallow crop margin	27	45	27	28
Retain winter stubbles	28	57	28	20
Unsprayed spring sown cereals or legumes	30	155	30	70
Unsprayed spring sown cereals retaining winter stubbles	31	210	31	117
Wildlife cover crop on improved land	33	114	33	61

Unharvested cereal headland	34	3	34	3
Woodland - stock exclusion	100	10438	100	5747
Trees and scrub - establishment by planting	101	191	101	148
Trees and scrub - establishment by natural regeneration	102	268	102	181
Scrub - stock exclusion	103	437	103	214
Wood pasture	104	23	104	8
Historic parks and gardens	106	119	106	78
Calaminarian grassland	109	1	109	1
Lowland dry heath with less than 50% western gorse	115	87	115	44
Lowland dry heath with more	116	60	116	24

than 50% western gorse				
Lowland wet heath with less than 60% purple moor- grass	117	18	117	11
Lowland wet heath with more than 60% purple moor-grass	118	19	118	11
Lowland heath habitat expansion - establishment on grassland	119	56	119	39
Lowland unimproved acid grassland	120	636	120	465
Lowland unimproved acid grassland - reversion (pasture)	121	270	121	196
Lowland unimproved acid	122	51	122	36

grassland - reversion (hay cutting)				
Lowland unimproved neutral grassland - pasture	123	358	123	245
Lowland unimproved neutral grassland - hay meadow	124	390	124	244
Lowland unimproved neutral grassland - reversion (pasture)	125	345	125	251
Lowland unimproved neutral grassland - reversion (hay cutting)	126	225	126	168
Lowland unimproved calcareous grassland	128	50	128	20

Lowland unimproved calcareous grassland - reversion (pasture)	129	9	129	4
Lowland unimproved calcareous grassland - reversion (hay cutting)	130	11	130	7
Conversion from arable to grassland (no inputs)	131	50	131	24
Conversion from improved grassland to semi- Improved grassland (hay cutting)	132	129	132	88
Lowland marshy grassland	133	2758	133	1705

Lowland marshy grassland - reversion (pasture)	134	121	134	68
Lowland bog and other acid mires with less than 50% purple moor-grass	139	112	139	68
Lowland bog and other acid mires with more than 50% purple moor-grass	140	113	140	59
Lowland bog and other acid mires - restoration (no grazing)	141	41	141	16
Lowland bog and other acid mires - reversion (pasture)	142	23	142	17
Lowland fen	143	102	143	45

Lowland fen - restoration (no grazing)	144	6	144	4
Lowland fen - reversion (pasture)	145	9	145	10
Reedbed - stock exclusion	146	76	146	30
Reedbed - creation	147	3	147	3
Coastal grassland (maritime cliff and slope)	148	129	148	93
Saltmarsh - restoration (no grazing)	149	45	149	22
Saltmarsh - creation	150	4	150	1
Coastal vegetated shingle and sand dunes - creation	151	1	151	1
Red clover ley	153	64	153	33
Buffer zones to prevent erosion	156	493	156	296

and runoff from grassland				
Buffer zones to prevent erosion and runoff from grassland - ditch landscapes	157	56	157	46
Buffer zones to prevent erosion or run-off from land under arable cropping	158	81	158	34
Grassland managed with no inputs between 15 October and 31 January	159	631	159	239
No lime on improved or semi-improved grassland over peat soils	160	31	160	14
Grassland management for chough (feeding)	161	258	161	170

Grassland management for curlew (nesting and chick feeding)	164	43	164	20
Grassland management for curlew (adult feeding)	165	72	165	32
Hay meadow management for curlew (nesting)	166	15	166	9
Grassland management for golden plover (feeding)	167	2	167	1
Grassland management for lapwing (nesting and feeding)	168	53	168	31
Unsprayed spring sown cereals, oil seed rape, linseed or	169	2	169	2

mustard crop for lapwing (nesting)				
Uncropped fallow plot for lapwing (nesting)	170	2	170	3
Grassland management for ring ouzel (feeding)	171	12	171	8
Orchard management	172	231	172	133
Streamside corridor management	173	1549	173	560
Rough grass buffer zone to prevent erosion and run-off from land under arable cropping	174	43	174	29
Management of rough grassland - enclosed land	175	169	175	92
Additional Management	400	290	400	110

Payment - Stock management				
Additional Management Payment - Mixed grazing	401	504	401	355
Additional Management Payment - Control burning first 0.00 - 3.00 ha	402	29	402	74
Additional Management Payment - Re-wetting	403	82	403	33
Additional Management Payment - Grazing management for dung invertebrates	405	31	405	17
Additional Management	411	2246	411	1034

Payment - Reduce stocking				
Access - permissive access areas	505	36	505	29
Boardwalks	508	2	508	2
Geotextiles	511	2	511	7
Hard Surfacing Footpaths	512	1	512	1
Track - New basic - no stone	526	11	526	70
Track - New – stone bought in	527	53	527	69
Track – New - stone won on site	528	24	528	65
Squirrel hoppers - for control of grey squirrels outside red squirrel areas	550	1	550	16
Establish Red Clover Lay	551	50	551	30
Hard Surfacing	552	1531	552	955
Pond Creation	564	128	564	87
Pond Restoration	565	534	565	352

Establish Grass Lay	581	41	581	27
Removal of Conifers	605	23	605	17
Restoration Pruning of Orchard Trees	606	5	606	5
Tree Pollarding	607	2	607	2
Tree Shelter [60cm with stake]	608	69	608	95
Trees – Standards	610	18	610	14
Trees and Shrubs – transplants	611	120	611	100
Trees and Shrubs – Whips	612	24	612	14
Basic Re-stocking: <5ha coupe size – over 350m altitude	613	2	613	6
Basic Re-stocking: <5ha coupe size – between 250 and 350m altitude	616	2	616	12

Basic Re-stocking: <5ha coupe size – below 250m altitude	619	5	619	25
Enhanced Re-stocking: <5ha coupe size – over 350m altitude	622	1	622	3
Enhanced Re-stocking: <5ha coupe size – between 250 and 350m altitude	625	2	625	27
Enhanced Re-stocking: >5 to 20ha coupe size – between 250 and 350m altitude	626	2	626	4
Enhanced Re-stocking: <5ha coupe size – below 250m altitude	628	9	628	41

Enhanced Re-stocking: >20ha coupe size – below 250m altitude	630	1	630	1
Re-stocking: Broadleaves - PAWS, ASNW and Core and Focal networks	631	40	631	132
Re-stocking: Broadleaves - All other sites	632	54	632	87
Chemical thin	634	3	634	5
Clear fell conifer and extract using skyline on PAWS	635	2	635	6
Re-spacing natural regeneration to favour native broadleaved species or mixed woodland	636	2	636	64
Coppicing	644	113	644	236

Sabre Planting [no fence planting]	646	10	646	8
Spiral Rabbit Guards	647	49	647	81
Bracken Control - Aerial Spraying	650	352	650	202
Bracken Control - Hand Knapsack Sprayer	651	544	651	261
Bracken Control - Mechanical Two Cuts/Yr	652	824	652	481
Bracken Control - Tractor Mounted Sprayer	653	101	653	50
Bramble / Scrub Control - Hand Knapsack Spraying	654	54	654	31
Heather management by burning	656	26	656	57

Heather management by cutting	657	141	657	125
Reed Cutting	660	15	660	5
Reed Planting – Bought in seed	661	4	661	5
Rhododendron Control - <1.5m	663	108	663	85
Rush / Molinia Management – mechanical control	664	330	664	233
Scrub Clearance – hand	665	1028	665	693
Scrub Clearance – mechanical	666	267	666	165
Sward Enhancement Using Native Seed	667	16	667	6
Weed Wiping	668	44	668	43
Invasive Plant Species control	669	365	669	305
Rhododendron clearance - >2.5m	670	56	670	93

Rhododendron Control – 1.5 to 2.5m	671	78	671	90
Ride and open ground mechanised mowing for conservation reasons	672	7	672	12
Geojute Matting	681	7	681	0
Heather cutting and removal	683	1	683	18
Thin predominantly broadleaf woodland - extract	684	115	684	386
Thin predominantly broadleaf woodland - waste	685	31	685	87
Thin predominantly conifer woodland - extract	686	34	686	102

Thin predominantly conifer woodland - waste	687	5	687	18
Ring Barking	688	9	688	10
Grazed pasture - low inputs	15b	2531	15b	1996
Grazed pasture - no inputs and mixed grazing	15c	619	15c	227
Grazed pasture - low inputs and mixed grazing	15d	410	15d	339
Management lowland marshy grassland with mixed grazing	19b	144	19b	100
Management lowland and coastal heath with mixed grazing	20b	2	20b	1
Management grazed saltmarsh	21b	24	21b	15

with mixed grazing				
Management of sand dunes with mixed grazing	25b	10	25b	5
Plant unsprayed root crops without direct drilling	32b	371	32b	116
Unfertilised and unsprayed cereal headland	34b	11	34b	8
Grazing management of open country	41a	1671	41a	591
Grazing management of open country with mixed grazing	41b	140	41b	66
Brashing: access and picnic areas			520	7
Basic Re-stocking: >20ha			615	7

coupe size: over 350m altitude		
Basic Re-stocking: >5 to 20ha coupe size between 250 and 350m altitude	617	12
Basic Re-stocking: >20ha coupe size: between 250 and 350m altitude	618	2
Basic Re-stocking: >5 to 20ha coupe size: below 250m altitude	620	12
Enhanced Re-stocking: >5 to 20ha coupe size: over 350m altitude	623	3
Enhanced Re-stocking: >20ha	624	2

coupe size: over 350m altitude		
Enhanced Re-stocking: >20ha coupe size: between 250 and 350m altitude	627	1
Enhanced Re-stocking: >5 to 20ha coupe size: below 250m altitude	629	17
Re-stocking: Riparian zones	633	4
Heather restoration by seed and mulch	658	7
Woodland: Formative pruning of broadleaved trees	694	31
Woodland: High pruning of	695	24

broadleaved trees			
Woodland - light grazing		176	62
Woodland: Pruning conifer trees		696	1
Total number of individual option contracts	55248		30531

Table C.2. GE management option descriptions. The table shows the option number and the total number of management contracts awarded by year (Option count) (RPA, 2017).

Description	**Option Number**	**Option Count 2017**
3m wildlife corridor - include trees and shrubs	1	169
3m wildlife corridor include earth bank and tree/shrub planting	2	114
Wildlife corridor - wooded strip	3	104
Hedgerow management - both sides	4	3253
Enhanced hedgerow management - both sides	5	2180
Double fence gappy hedges 3m width	6	571
Continued management of existing streamside corridor	8	2886
Restore traditional orchard	11	114
Create new orchard	12	192
Plant individual trees	13	403
Grazed pasture - no inputs	15	10759
Upland Heath	16	25
Blanket Bog	17	9
Upland Grassland	18	125
Management lowland marshy grassland	19	5306

Management lowland and coastal heath	20	82
Management grazed saltmarsh	21	82
Maintenance existing hay meadow	22	1634
Small areas in corners of field revert to rough grassland/scrub	23	272
Woodland edge to develop out to adjoining (improved) fields	24	16
Management of sand dunes	25	17
Fixed rough grass margins on arable land	26	214
Fallow crop margin	27	39
Retain winter stubbles	28	154
Undersown spring cereals next to watercourses	29	17
Unsprayed spring sown cereals or legumes	30	510
Unsprayed spring sown cereals retaining winter stubbles	31	146
Unsprayed root crops on improved land	32	676
Wildlife cover crop on improved land	33	218
Unharvested cereal headland	34	4
Create wildlife pond - enclosed improved land	35	36
Buffering existing unfenced in-field ponds	36	55
Management of scrub etc from historic features	39	26
Fence around stock excluded woodland	40	806
Mechanical bracken control	44	343

Maintenance of traditional weatherproof buildings	45	251
Grazed pasture - low inputs	15b	10547
Grazed pasture - no inputs and mixed grazing	15c	1201
Grazed pasture - low inputs and mixed grazing	15d	2105
Management lowland marshy grassland with mixed grazing	19b	412
2m wildlife corridor- tree and shrub planting	1b	298
Management lowland and coastal heath with mixed grazing	20b	5
Management grazed saltmarsh with mixed grazing	21b	7
2m wildlife corridor include earth bank and tree/shrub planting	2b	137
Plant unsprayed root crops without direct drilling	32b	753
Unfertilised and unsprayed cereal headland	34b	11
Wildlife pond on enclosed land - variable size	35b	75
Grazing management of open country	41a	1345
Grazing management of open country with mixed grazing	41b	74
Hedgerow restoration with fencing	42a	1681
Hedgerow restoration without fencing	42b	1931
Double fence and restore hedge banks with planting	43a	238
Double fence and restore hedge banks without planting	43b	64
Maintenance linear permissive access - Tir Gofal bridleway	46a	96
Maintenance linear permissive access - Tir Gofal footpath	46b	315

Hedgerow management external boundary (one side only)	4b	3128
Double fence gappy hedges 2m width	6b	624
Create a streamside corridor on improved land on one side of a watercourse	9a	955
Create a streamside corridor on improved land on one side of a watercourse with tree planting	9a	18
Create a streamside corridor on improved land on both sides of a watercourse	9b	1170
Create a streamside corridor on improved land on both sides of a watercourse with tree planting	9b	28
Total number of individual option contracts		59026

Appendix 2

Supplementary material for Chapter 5

Overcoming barriers to CSS uptake through the decentralisation of agri-environment policy

David Arnott, David Chadwick, Rebecca Thompson, Sophie Wynne-Jones, David L. Jones

Table SI3. Management levels and offer descriptions for the Environmental Stewardship and Countryside Stewardship agri-environment schemes. (Defra, 2005; Natural England, 2018)

Environmental Stewardship Scheme		Countryside Stewardship Scheme	
Levels	Description	Levels	Description
Entry Level Stewardship (ELS)	Includes Uplands ELS: simple and effective land management agreements with priority options	Mid-Tier	Multi-year agreements for environmental improvements in the wider countryside, that include multi-year options and capital items plus support for organic conversion and management.
Organic Entry Level Stewardship (OELS)	Includes Uplands OELS: organic and conventional mixed farming agreements	4 x Wildlife Offers: Arable; Lowland Grazing; Upland; and Mixed Farming	Provides funding to help farmers improve the wildlife on their farm, increasing year-round habitats and helping pollinators to thrive.
Higher Level Stewardship (HLS)	More complex types of management and agreements tailored to local circumstances	Higher-Tier	Multi-year agreements for environmentally significant sites, commons and woodlands where more complex management requires support from Natural England or the Forestry Commission, that include multi-year options and capital items.
		Capital grants	A range of 2-year grants specific to outcomes for hedgerows and boundaries, developing implementation plans, feasibility studies, woodland management plans, woodland creation (establishment), and tree health.
		Facilitation Fund	Supports groups of land managers to collectively deliver landscape scale objectives.

Table SI2. Example of the coding used to identify themes following semi-structured interviews to identify barriers to the uptake of the Countryside Stewardship Scheme.

Fit	Good fit (GF)	Environmental benefits (EB) Minimum change (MC) Allows extensive system (EXT) Benefits to farm (BtF) Fits with current practice (CP)
	No fit (NF)	Restricts production (PF) Intensive system (IS) No options available (NO) Not in target area (NTA)
	Forward thinking (FT)	Changing system to embrace public goods (CS)
Financial (Fin)	Positive (FinP)	Capital works payments (CPP) Recompense (REC) Support to LFA farms (SLFA)
	Negative (FinN)	Lower payments (LowP) No financial benefit (NFB) Advisor costs (AC) High financial risk (HFR) Farm viability without payments (FV) Late payments (LP)
Scheme design (SD)	Administration (SDA)	Complex application process (SDC) Time consuming (SDT) Need for private advisors (SDAD) Lack of continuity (SDCON) Targeting prevents access (SDT)
	Option management (SDOM)	No flexibility (SDF) Easily managed (SDEM) Need for recordkeeping (SDRK)
	Risk (SD)	Threat of penalties (SDP) Inspections (SDI) Risk on farmer (SDFR)
Relationships (Rel)	With NE and RPA (RelNE)	Supportive (Sp) Distant/difficult (DD) A threat (Thr)
	With National Park (RelNPA)	Positive (Pos) Local (Loc) Good communication (Com) Partnership (Part)
	Family and friends (RelFF)	Local advice (LA)

		Local Knowledge and experience (LKE) Word of mouth (WoM)
Values and beliefs (VB)	Environmental (Env)	Nature friendly farming (NFF) Conservation (Con) Good farmer principles (GFPE) Family traditions (FT)
	Production (Prod)	Good farmer principles (GFPP) Family influence (FI)

SI3: Example of the question guide used during interviews with farmers in the North York Moors National Park.

Question set: Farmers who have previously been in agri-environment schemes but no longer are.

Demographics

A. Farm type:

B. Farm Size:

C. Gender:

D. Age:

E. Length of time farm in family:

F. Do you have a successor to the farm:

G. What AES have you previously been in?

Questions

1. It would be really helpful to hear about your previous experience of AES, can you start by telling me about where you found the experience to be positive and where you encountered barriers and problems?

Ask for examples

Ask interviewee to expand on areas if necessary

2. What are the main reasons for you leaving the previous agri-environment Scheme and not joining another?

Ask interviewee to expand upon reasons given.

3. What are the main barriers preventing you from joining Countryside Steward Scheme in the future?

Expand if necessary, to determine if barriers are physical i.e., no suitable options or administrative i.e., too much bureaucracy or perceived?

How much does previous experiences with AES influence decision to join CSS?

Are the barriers to joining CSS perceived due to previous experience or actual following advice?

4. What research, if any, have you done into your eligibility to join CSS and where have you gone for advice?

What advisors were used; are they independent, government advisors or other farmers?

Can they explain the benefits of using an advisor?

What barriers to eligibility were identified though the advisory process?

5. What do you think could be done to overcome barriers to joining CSS in order to make the process of joining easier?

Determine if changes are procedural or physical

What improvements could be made to the advisory system?

6. What role, if any, do you think the park authority could play in reducing barriers for farmers wanting to join Countryside Stewardship Schemes?

Do they see the NYMNPA having an advisory or physical role to play?

7. What changes will you make to farming practice to compensate for the potential loss of BPS payments?

How will a loss of payment impact the business?

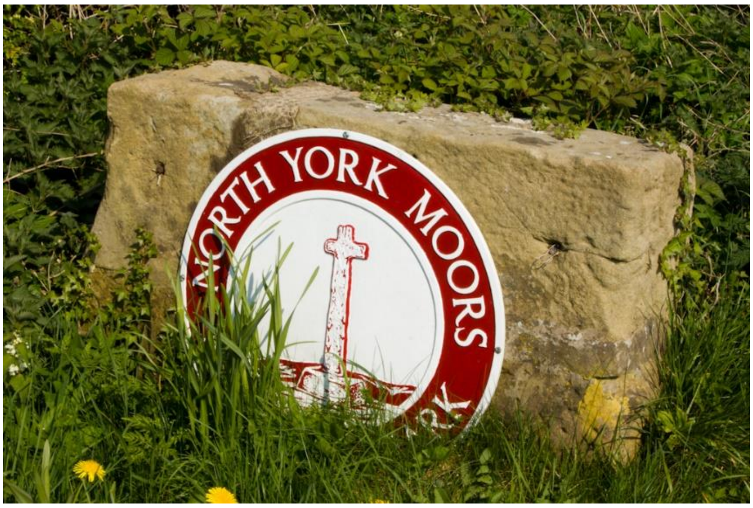
Ask interviewees to expand if necessary.

8. What opportunities, if any, do you think Countryside Steward Schemes might present to your business following the removal of BPS?

Ask interviewees to expand if necessary.

What role do they see CSS playing in the future?

Understanding barriers to the uptake of the Countryside Stewardship Scheme in the North York Moors



Rebecca Thompson (Future Farming Policy Officer, NYMNPA)

David Arnott (PhD candidate, Bangor University)

November 2019

Executive Summary

In the context of the North York Moors, we focused our study on five key areas as detailed below:

- Reasons preventing participation in agri-environment schemes (AES) .
- Reasons for joining AES.
- Experiences of AES.
- Ways of overcoming barriers to the uptake of the Countryside Stewardship Scheme (CSS).
- The role of the North York Moors National Park Authority (NYMNPA) in overcoming barriers to CSS uptake.

These areas are not separate and, in this report, we show how farmer perceptions and experiences are linked to create barriers to the uptake of CSS.

Reasons preventing participation in AES

Our research confirms the findings of other studies which show that the farmer's decision to participate, or not, is influenced, not by an individual factor, but by a complex mix of personal, family and farm business factors. On production focused farms, reasons for non-participation are driven by the lack of fit to the current farming whilst on other farm types, scheme complexity, a lack of financial benefit and risk of penalties are examples of where participating farmers have deemed transaction costs to outweigh the benefits of participation.

Reasons for joining AES

Reasons for joining AES can be categorised into 5 main groups, benefits to the farm, forward thinking, environmental, financial and goodness of fit. However, like those who have not joined AES, reasons for joining are complex with participants often citing a variety of reasons which interlink to influence the decision-making process.

Experiences of AES

Experiences with early AES, either the North York Moors Farm Scheme (NYMFS), delivered and financed by the NYMNPA or national schemes, created no barriers to advancement into future AES.

All participants who participated in early AES schemes went on to successfully apply for entry into the Environmental Stewardship Scheme (ESS). Ease of entry, goodness of fit and financial incentives are seen to be the areas in which the majority of participants recount positive experiences of the ESS whilst negative experiences predominantly focus around payment delays, the risk of penalties and frustrations surrounding the inability to communicate with the relevant authority. The majority of farmers in CSS report mixed experiences with the scheme with the number of negative experiences outweighing the positive. However, despite these negative experiences, none of the participants expressed a desire to leave the scheme; on the contrary some have the view that it is worth being in the scheme despite issues (i.e., benefits outweigh the negatives).

Barriers to the uptake of the Countryside Stewardship Scheme

Barriers to the uptake of CSS in the NYMNP can be grouped into six main themes, previous ESS experience, financial, scheme administration, goodness of fit to the current farming system, a lack of choice and personal reasons affecting the farmer's decision.

Ways of overcoming barriers to CSS uptake

Zero adopters, participants who have never been in a scheme suggest barriers to uptake of AES being overcome through the provision of more knowledgeable local advisors and the implementation of a simple, localised scheme which works alongside production and gives the farmer more control over delivery.

Passive adopters, namely those previously in AES and some of those in ESS, support the localisation and simplification of AES but some suggestions made by these groups could easily be implemented to reduce the barriers and promote adoption. One example of this is the perceived need to develop partnerships which improve the relationship between the farmer and the scheme provider.

Active adopters also support a move to a simpler, localised scheme and the creation of partnerships but suggestions made by this group demonstrate a greater willingness to engage and find compromise through (i) improved communication channels, (ii) partnerships which see farmers working with scheme providers as equal partners in the delivery of environmental objectives, and (iii) the provision of training and advice on sustainable farming and the provision of environmental goods.

The role of National Park Authorities in overcoming barriers to CSS uptake

All participants in this study see a key role for NPAs in future AES, be it as the primary deliverer of AES or as a link between the government and the farmer in both advisory and administrative roles.

Contents

1. Introduction

In England, the ESS, currently in the process of being phased out (the last set of contracts end on the 31st Dec 2023; Defra, 2019), has been replaced by the CSS which had its first contracts awarded in 2016 (Defra, 2015). However, the transition from ESS to CSS has seen a dramatic drop in the take-up of AES within the farming community. In 2014, the total number of AES agreements (entry and higher level) was 46,500 covering ~7.7 million hectares of agricultural land. In 2018, the number of agreements (ESS, entry and higher level and CSS) in force had reduced to 32,500 and the land managed under schemes had reduced to ~3.7 million hectares (Department for Environment, Food and Rural Affairs; Department of Agriculture, Environment and Rural Affairs (Northern Ireland); Welsh Government and The Scottish Government, 2019). Post 2023, CSS will be the only mainstream AES available to farmers until 2027, where a UK departure from the EU will see the phasing out of current schemes and the introduction of an Environmental Land Management System (ELMS) which will replace current AES and the Basic Payments Scheme (BPS) (Defra, 2018). As ESS will end before ELMS is due to be fully up and running, participants with contracts ending between 2019 and 2023 will either need to apply to join the CSS, wait until the ELMS is operational or consider alternative land management options as a means to replace income lost through previous AES participation and support received through the Basic Payment Scheme. As shown above, indications are that gaps in AES coverage are appearing across England because many farmers are not making the transition from ESS to CSS. Therefore, as part of the transition process, the Department for Environment, Food and Rural Affairs (Defra) has started a series of tests and trials in preparation for the first pilot of ELMS which will begin in 2021 (Defra, 2018). The NYMNPA has been selected, along with a number of other organisations, to conduct research on behalf of Defra that will help to inform the pilot. Part of this research aims to enhance government understanding on farmer intentions to join CSS when ESS contracts expire and to identify what barriers, perceived or actual, exist to prevent a transition to CSS from ESS. This report delivers on these research objectives for the North York Moors National Park

(NYMNP) through the results of a series of in-depth interviews conducted with farmers across various farm types and AES participation categories.

2. Objectives

We focused our study on five key areas as detailed below:

- Reasons preventing participation in AES.
- Reasons for joining AES.
- Experiences of AES.
- Ways of overcoming barriers to CSS uptake.
- The role of NYMNPA in overcoming barriers to CSS uptake.

We used these study areas to achieve the main objective of this study which is to interview farmers of varying types, and across different categories, within the NYMNP to:

- Gain a better understanding of barriers to the uptake of the CSS.
- Determine whether these barriers are actual or perceived.
- Identify potential ways of breaking down barriers to promote adoption.
- Determine if the NYMNPA has a role to play in breaking down barriers to uptake.

3. Methodology

Because the willingness to participate, or not, in AES is complex, a deep understanding of people's perceptions, attitudes and behaviour is needed. Quantitative studies have the advantage of measuring the reactions of many subjects to a limited set of questions allowing the comparison and statistical aggregation of the data. However, qualitative studies allow the researcher to reveal and understand the complex processes behind the decision-making process (Shah and Corley, 2006) and provide a means for developing an understanding of complex phenomena from the perspectives of those who make the decisions (Denzin and Lincoln, 2011). This study was based on 42 in-depth interviews with farmers, across four AES behavioural categories and four land use types (see below). These qualitative procedures enable us to gain insight into the underlying attitudes towards CSS and its uptake.

3.1. Sample design and participant selection procedures

The sample was stratified to include the four primary farm types within the NYMNP (arable, dairy, LFA grazing livestock and lowland grazing livestock), taking into account a mix of ages and male and female participants. In addition, the participants had to live in different geographical locations across the NYMNP, since agricultural land classifications and habitat vary across the region.

Based on current involvement in AES, four groups were defined *a priori:*

- Farmers currently in ESS.
- Farmers currently in CSS.
- Farmers who have previously been in AES but no longer are.
- Farmers who have never been in an AES.

Farmers on the NYMNPA database who have indicated a willingness to be contacted by the NYMNPA were contacted by email and phone, explaining the objectives of the study, and asked if they would be willing to participate in face-to-face interviews with the researcher. Final participants were primarily selected to ensure contributions from arable, dairy, LFA grazing and lowland grazing farm types in each of the four groups. They were further selected to ensure variety in age and gender demographics.

3.2. Interviewing procedures and analysis

Semi-structured Interviews, lasting on average 57 minutes, were conducted on a face-to-face basis in the participant's home using a pre-defined interview guide which was flexible enough to allow interviewees to discuss issues arising throughout the interview. Questions varied slightly between the four groups to reflect differences in current and historic willingness to participate. Through the interviews, attitudes towards AES were explored along with actual and perceived barriers to uptake. Other areas explored included how farmers thought barriers could be better overcome and what role they thought the NYMNPA may play in helping break down barriers to promote greater uptake of AES.

A grounded theory approach (Glaser & Strauss, 1967) was used to gain an understanding of participants' perceptions towards AES. In-depth interviews were digitally recorded, fully transcribed and analysed using thematic analysis techniques (Castleberry and Nolen, 2018). The analysis was performed through a process of: (1) reading and familiarization with the interview transcripts and (2) completing coding to identify reasons for joining and leaving AES, barriers to the uptake of CSS within the NYMNP, suggestions for overcoming barriers to CSS uptake and the role that the NPA could play in overcoming barriers to CSS uptake. For each individual code, we collated all instances of text where that code appeared in the dataset. Themes were developed when codes clustered together. The themes were then revised by coding and collating more data from the original interview transcripts. The number and percentage of all participants who mentioned a theme were then recorded for each theme. Each theme was then analysed to identify primary reasons for AES participation, positive and negative experiences of AES, barriers to uptake of the CSS and ways of overcoming barriers to CSS uptake, including the role of the NPA's. In order to increase the reliability and validity of the process all of the fieldwork was undertaken by the same researcher. Themes identified were reviewed and verified by the Future Farming Officer of the NYMNPA who was in attendance during ~70% of the interviews and who read and reviewed all transcripts.

3.3. Pathways to AES uptake

Barriers to the uptake of the Countryside Stewardship Scheme are better understood through a study of experiences resulting from encounters with AESs since their introduction in England in 1987 (Ovenden et al., 1998). Figure 1 shows pathways followed by farmers in the North York Moors and highlights where they have encountered positive and negative experiences along the way. This pathway framework is utilised to create the structure of this paper. It tracks the decision-making process from initial decisions to join AES through to the decision to join CSS, identifying barriers and opportunities at each stage of the decision-making process.

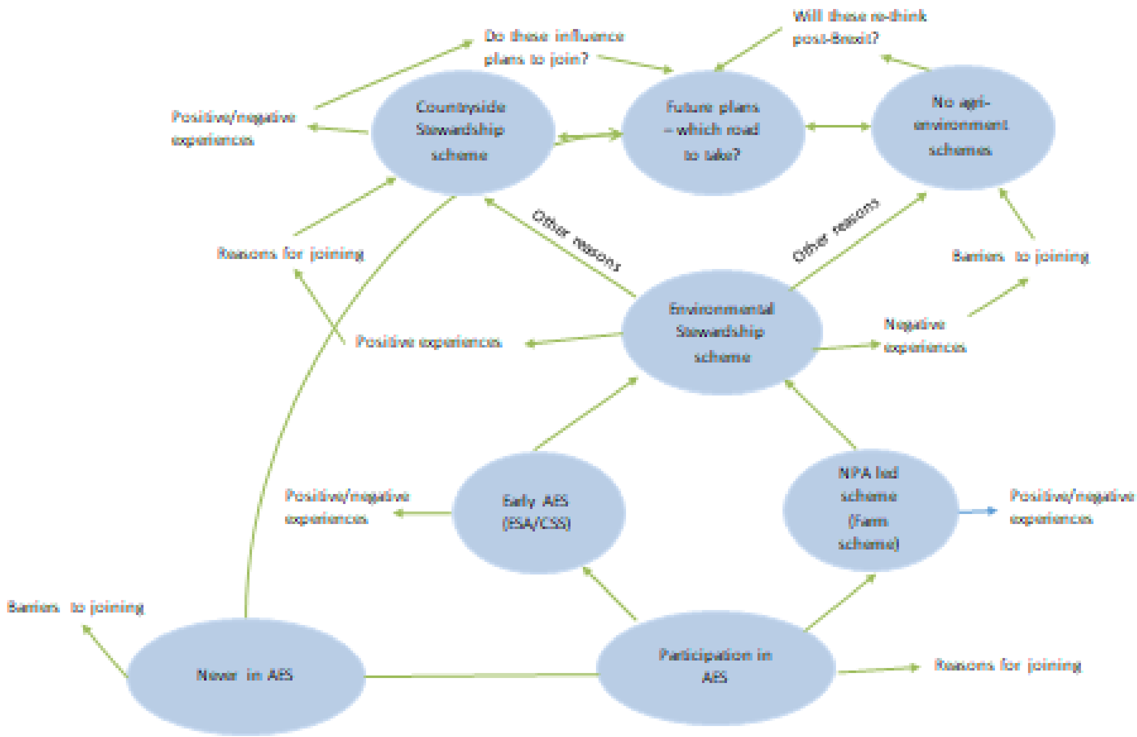


Figure 6: Framework showing agri-environment pathways for farmers in the North York Moors.

4. Results and Discussion

When discussing the uptake of AES in the NYMNP there are fundamentally two categories of farmers, those who join AES and those who don’t. In this study we begin by identifying the factors separating these two categories i.e., the reasons preventing participation and the motivating factors encouraging scheme uptake.

4.1. Reasons preventing participation in AES

Since the 1980’s, AES’s have been widely available to farmers, through national schemes such as Environmentally Sensitive Areas schemes (ESAs) and the first Countryside Stewardship Scheme (Natural England, 2012). Within the NYMNP, an additional AES, the NYMFS, targeted specific dales within the national park. By 2012, much of the farmland in the NYMNP was managed under ESS, 634 agri-environment agreements were in place covering 86,000 hectares of farmland, and 89% of the moorland (NYMNPA, 2013). This means a high proportion of the 978 commercial farms in the NYMNP (Harper et al., 2015) will have participated, at some level, in some form of AES. This made the category of 'Farmers who have never been in an AES' the most difficult category of farmer to identify. Of the 42 participating farmers only 7 (17%) had never previously been involved in AES and of these only one was in the LFA grazing farm type. This was to be expected as habitats found on LFA grazing farms often have the best goodness of fit to AES options (Arnott et al., 2019).

Fig. 2 shows the main reasons preventing this category of farmer from actively engaging and participating in AES. Only one (Male, lowland grazing, 63) of the seven participating farmers in this category had not previously enquired about AES participation. This farmer was 55 years old when succeeding the farm and took a 'business-as-usual' approach to AES participation. This was evident throughout the interview: "Dad wouldn't have had anything to do with an agri-environment scheme, and he'd keep out of it like. He was old school; he didn't want anything to do with it". Whilst he did express an interest in AES participation as an additional income stream, there was no active attempt to gain knowledge on the application process, "Half the letters I don't even open or I just chuck in the bin. If it's Single Farm Payment then I open it, that's all I open. So, they've maybe sent stuff, I just don't know. Too much hassle". Further exploration by the interviewer revealed underlying literacy and eyesight problems, "forget the paperwork, I'm not doing anything. I can't spell and I can hardly read, I'm struggling filling that in [farm business paperwork], you know, 'cos my eyesight's so bad as well like" and a mistrust of the authorities, "It's big distrust in everyone 'cos people tell you one thing and then when it happens it's another thing" creating barriers to AES uptake.

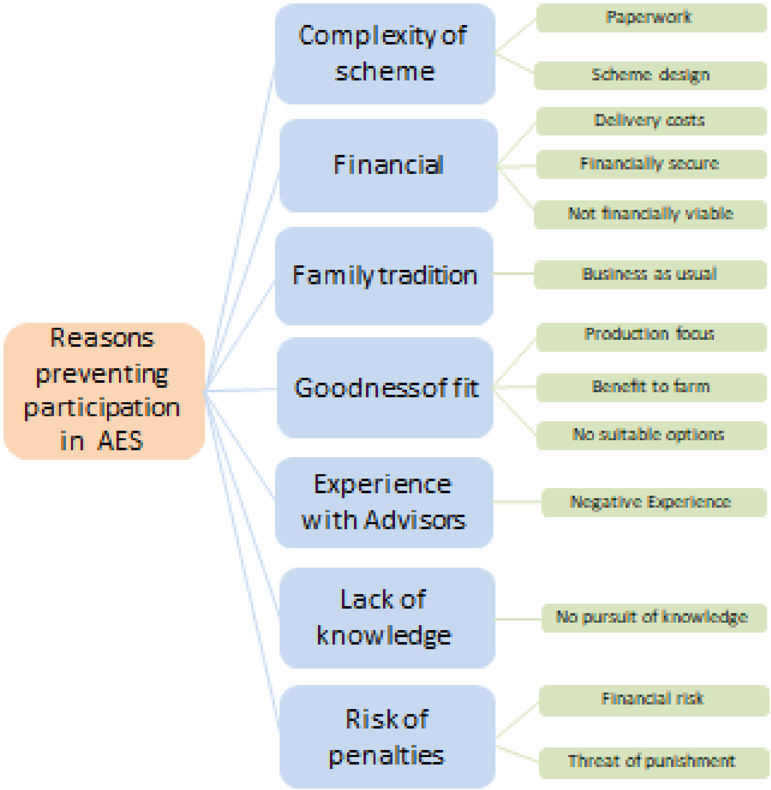


Figure 7: The main reasons preventing participation in agri-environment schemes in the North York Moors.

Whilst the remaining participants cite a number of reasons preventing them from joining AES (Fig. 2) none of them could be classed as 'resistors' to the idea of AES (Morris et al., 2000) as they have all at some stage explored the possibility of participation. Our research confirms the findings of other studies (Falconer, 2000; Morris and Potter, 1995; Van Herzele et al., 2013) which show that the farmer's decision to participate, or not, is influenced, not by an individual factor, but by a complex mix of personal, family and farm business factors. For many, a lack of fit to current farming practices creates the primary barrier to participation, as illustrated in the following quotes.

"We've got to get on with doing some farming, and it's easier to just farm all your fields than it is to start splitting them up and putting little bits of strips in or whatever" (Arable, male, 43).

"What we are managing is farmed intensively as farmland but we do have set aside acres. Quite a lot of our farm is quite environmental, woods and things. The result is that that doesn't fit in desperately well with any of the schemes because, I'll be honest, I don't want to give up any more than what I have given up. I don't want to create headlands", (Dairy, male, 64).

All schemes require participants to incur transactions costs, to varying levels (Falconer, 2000). Scheme complexity, a lack of financial benefit and risk of penalty factors are examples of where participating farmers have deemed transaction costs to outweigh the benefits of participation.

"The amount of money I was going to get for managing the hedges was so small that, by the time I had filled in all the paperwork, it was just not - I can't see an economic benefit to me", (Dairy, male, 34).

"I looked at that (CSS) but it is too complex, in the financing and what is required. It would cost me more money to do it; it's not worth it for somebody like me. I just looked at the paperwork. and I made a decision, whether my decision was right or wrong, you can argue that and I can't remember the detail but I would have looked at it on paper, and thought, 'good god, I can't do that", (LFA grazing, female, 77).

This study supports Hejnowicz et al. (2016) who found farmers regarding potential sanctions imposed by Natural England (NE) as disproportionate, with some suggesting that the fault lies, in part, in the 'uncertainty' and 'inconsistency' with which NE tackle issues.

"It was just that the financial benefit and what they can come back at you for and take the money off, just isn't worth it. You can't be going round taking photographs of stuff and messing about, and if you don't do this work, we'll come back. I don't want it. At my age I don't need it. We've heard it from other people about penalties", (Lowland grazing, male, 54).

The inconsistency noted by Hejnowicz et al. (2016) is also reflected in the experience of the same farmer whose negative experience with a Natural England advisor led to them not signing the application.

“The guy from Natural England, he had no idea. He had a booklet that big and he had no idea, did he? He just hadn’t a clue. This was for the higher tier scheme. We got to the point of signing, but in the end we didn’t”, (Lowland grazing, male, 54).

In summary, all farmers interviewed in this category could be classed as ‘conditional non-adopters’ (Morris and Potter, 1995) in that they have assessed various schemes and have determined that in their current format there is either no goodness of fit to the farming system or that the transaction costs outweigh the benefits of participation. Whilst it is difficult to overcome ‘goodness of fit’ barriers to uptake issues such as, scheme complexity, a lack of financial benefit, the risk of penalty factors and experiences with scheme providers are barriers to uptake which could be overcome in the design and delivery of future schemes.

4.2. Reasons for joining AES

Participants currently in ESS and CSS (n = 21) were asked to give the main reasons for joining AES. The results can be categorised into 5 main groups, benefits to the farm, forward thinking, environmental, financial and goodness of fit (Fig. 3). However, like those who have not joined AES, reasons for joining are complex with participants often citing a variety of reasons which interlink to influence the decision-making process. Morris and Potter (1995) identified two groups of farmers participating in AES, ‘active adopters’, those for whom financial incentives and goodness of fit are important but who also have conservation concerns and ‘passive adopters’ whose interests are purely financial and goodness of fit to the farming system i.e. they are prepared to adhere to the scheme prescriptions if the financial remuneration is sufficient and that they only have to make small changes to current farm management practices.

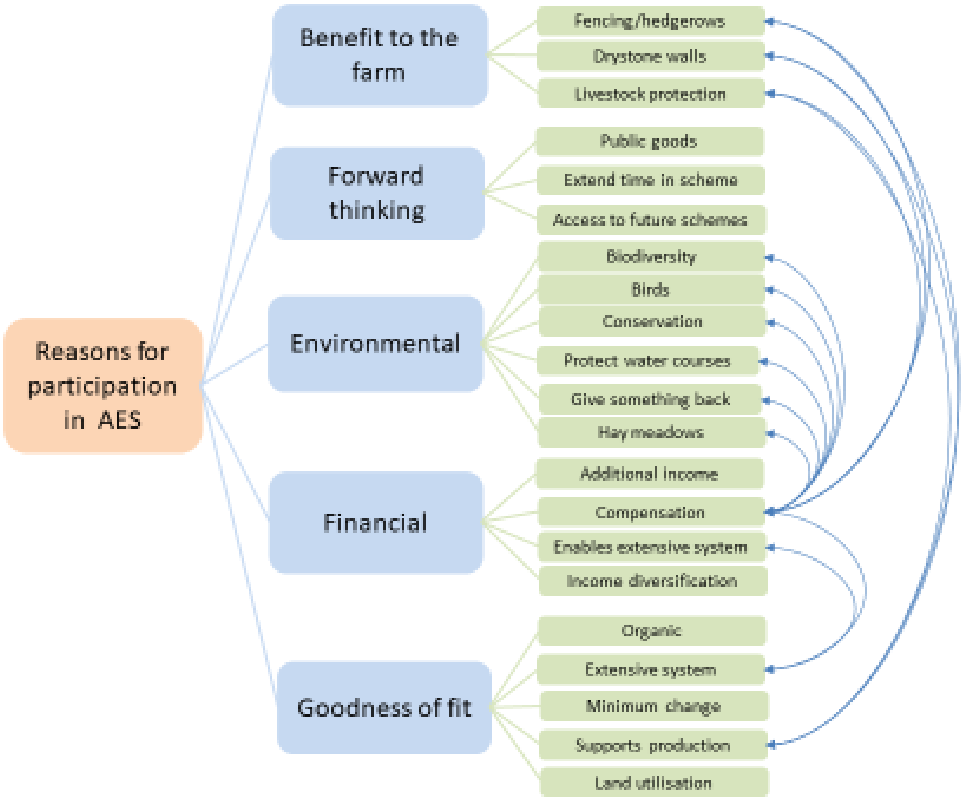


Figure 8: The main reasons for participation in agri-environment schemes in the North York Moors.

The farmers interviewed in this category meet these criteria but in additional we found a group, 'the forward thinkers' who have risen out of the uncertainty surrounding the future of agricultural policy in the UK.

Financial incentives feature high on the list of reasons for joining (n = 13, 62% of participants in this category) and this mirrors other studies into AES participation across the EU (Lastra-Bravo et al., 2015; Morris et al., 2000: Wilson and Hart, 2000). Whilst an increase in revenue was cited as a primary reason for joining by 43% (n = 9) of participants in this category, only 14% (n = 3, 1 x arable, 2 x dairy) named it as the only reason. The farmer interviews revealed close interconnectivity between financial incentives and other motivating reasons for joining and we use this to separate the farmers into active, passive (Morris and Potter, 1995) and forward-thinking categories.

Our 'passive adopters' use AES prescriptions and payments as a means to carry out improvements to the agricultural landscape (e.g., fencing, hedgerow and drystone wall maintenance and installation) and improve conditions for grazing livestock (e.g., the provision of shelter belts and the fencing off of unsuitable areas) that would not have been possible without external financial support systems. This is typified by, “The motivation was, it was a scheme that would allow us to do things like plant more hedges and things and get some financial help to do it. I just thought it seemed like a good idea to me” (Lowland grazing, female).

The ‘active adopter’ (n = 9, 43% of participants in this category) joined the scheme as there is a goodness of fit to their farming system, it fits with their ideology and the financial remuneration compensates them somewhat for the environmental benefits provided on the farm. All nine show a historical or personal interest in protecting both the natural and cultural landscapes in which they live.

“We’ve always looked at the farm in a conservation way because of where we are. We like where we are. It’s been a part of the farm that we’ve done as a part of a hobby that’s never brought any income in. And to actually be offered to do something, to actually get an income from it, or being able to be paid for instead of the farm paying for it, or we were paying for it off our backs”, (Lowland grazing, female, 68).

“I worked for the Cornfield Flowers Project right from its conception in various capacities, you know, eventually ending up as Project Officer until last year so I was into that job. It wasn’t much of a big step [moving into AES] in many ways”, (Lowland grazing, male, 79).

Agreeing with Defrancesco et al. (2008), we found farmers wishing to farm extensively are more willing to join an AES scheme if they feel the financial compensation offered in an AES contract fully covers the associated costs of reduced production capabilities. In the NYMNP, payments enable farmers to lower stocking rates and reduce fertiliser applications thus preventing further intensification.

“We couldn’t farm it like this to look after the grasses without payments. We would have to put more cattle down bottom end if we didn’t have that”, (LFA grazing, female, 33).

"If it is a decent payment then you can reduce your stock and that's what they are wanting when you are in these schemes. You can't put fertiliser on in these schemes so obviously land goes back", (LFA grazing, male, 59).

The 'forward thinkers' recognised a shift in policy towards a greener agricultural landscape where farmers will be required to deliver more in the way of public goods. In anticipation of this, they have embraced AES in the hope that a willingness to participate will ensure inclusion in schemes that arise following changes to UK agricultural policy.

"There was a lot of confusion in government and what not and there might not even be agreements in the future, so at least if you were going to get one for 10 years you had that security", (Lowland grazing, female).

"To be honest you could see the writing on the wall a number of years ago so I thought if we get into a scheme for whatever it means at least we have ticked that box so at some time in the future you would like to think that human nature would be good enough to say right, these lads that have been good enough to go into these schemes that were very difficult to administer, at least they did it so they should be given first dibs at the next lot that's coming" (Arable, male, 59).

In summary, the reasons for joining AES predominantly fit with the findings of previous studies for example, Wilson and Hart (2000). We have added to previous research through the addition of another category of farmer, the 'forward thinker' who, despite having some reservations, view AES as providing a level of security amidst the uncertainty surrounding future agricultural policy.

4.3. Experiences with early AES

Participants who are currently, or have previously been in AES (n = 35) were asked to share their experiences of being in AES starting from their early experience of the NYMFS or the first Countryside Stewardship scheme through to the current active AES (ESS and CSS).

4.3.1. The North York Moors Farm Scheme

The NYMFS ran from 1990 to 2013 when the final scheme agreement expired. It took a comprehensive approach which enabled farmers to respond to changes in the rural economy whilst guaranteeing the conservation of landscape, wildlife and historic features in the National Park and other positive environmental benefits (NYMNPA, 2019). Twenty two of the thirty-five participants currently or previously in an AES, recount experiences of being in a NYMNPA scheme. Fig. 4 gives a synopsis of farmer experiences with the NYMNFS. These experiences can be grouped into two main categories, experiences with NP staff and scheme administration and design. Participants describe having a very positive experience with the NYMNPA. This was created primarily through the availability of local administrators and advisors who used local knowledge to deliver individually tailored advice which met needs of both the NP and the local farming community. Only one participant reported a negative experience and that was with planning department and not with the AES scheme itself.

Figure 9: Word summary of the experiences of the North York Moor Farm Scheme

4.3.1.1. Experiences with NP staff

Administrators and advisors were seen as being helpful, reliable and responsive to farmer requirements. They were supportive and flexible enough to respond to challenges faced by scheme participants. The 'personal touch', appreciated by farmers, was created through discussion, compromise and the dissemination of information at group and individual meetings.

"With NP it's the fact that you have someone local advising, to come out and see you if you have any problems. It is hard to get hold of the NE guy, he has a big area and a lot to look after", (LFA grazing, male, 55).

"I liked the personal touch about the farm scheme. You came out, you looked at our farm and there was discussion. There were things that you guys wanted putting in that we weren't happy about. There was compromise", (Dairy, Male, age not supplied).

4.3.1.2. Scheme administration and design

The design of the NYMFS provided a 'goodness of fit' with farming systems, the paperwork was viewed as easy to complete, options were sensible and appropriate payments were paid in a timely fashion. Focusing on traditional boundaries, the NYMFS made revenue payments for the maintenance of hedgerows and drystone walls and offered capital grants towards the cost of repairs/restoration of dry-stone walls and the creation/regeneration of hedgerows which simultaneously delivered NYMNP objectives and benefits to individual farm systems. These characteristics mirror the 'passive adopters' primary reasons for joining AES; financially viable, goodness of fit and minimum work over-and-above normal work expectations and this is reflected in the positive recollections of this scheme.

"The North York moors paid on time. A week it took them. The park authorities are more flexible", (LFA grazing, female, 53).

"Well, it was basically payments for hedge planting and stone walls and keeping the farm tidy as much as anything and keeping the landscape and wildlife. We fenced off the riversides and planted trees", (LFA grazing, male, 48).

The transition from NYMFS to ESS went smoothly with many farmers gaining enough points through the hedgerows planted and/or drystone walls maintained through the NYMFS. The NYMNPA assisted in the transition phase through the provision of an advisory service which participants found extremely useful.

"I found application [for ESS] relatively easy but the NP gave me a big hand, they did a lot of the paperwork", (LFA grazing, male, 55).

Whilst scheme design and goodness of fit played a significant role in acceptance of the NYMFS, the addition of a local contact, delivering advice and support, contributed to an overall feeling that the NYMFS was a straightforward scheme that farmers were happy to be involved with.

4.3.2. National schemes

Five participants recalled experiences with early national schemes including the original CSS, catchment friendly farming and the uplands entry level schemes. Like the NYMFS, farmers participating in these schemes report a positive experience predominantly linked to the reasons to join given above.

"The countryside stewardship scheme was easy to work. It fit in. We did it because it suited our farm really. We didn't go into it for the money. We wanted some hedges because we had a lot of bare land – just wire fences, and we needed hedges for the shelter for the livestock", (Lowland grazing, male, 65).

In summary, experiences with early AES, either the NYMFS or national schemes, created no barriers to advancement into future AES. All participants who participated in the earlier AES schemes went on to successfully apply for entry into ESS.

4.3.3. Experiences with Current AES - The Environmental Stewardship Scheme

The ESS originally consisted of three elements, the Entry Level Stewardship (ELS), the Organic Entry Level Stewardship (OELS) and Higher-Level Stewardship (HLS) with an additional level, the Uplands Entry Level Stewardship (UELS), being added in 2010 (Natural England, 2010). Acceptance into ELS and UELS was determined by a points system and providing farmers met the points target and agreed to carry out simple, yet effective environmental work they would be accepted into the schemes (Natural England, 2011). OELS was also based on points but they were calculated in two ways: farmers automatically received points per ha for the organic land entered into the scheme, reflecting the inherent environmental benefits delivered through organic farming and the remaining points were made up from chosen management options (Natural England, 2011). HLS is a targeted and competitive scheme only available to farmers and land managers in particular areas of the country or with particular high priority features on their holding. Payment levels depend on the number of options the farmer is able to deliver (Natural England, 2011).

Thirty-five of the forty-two participants in this study have experience of ESS. Of them fourteen have since left AES, eleven are still in ESS and ten have moved into CSS. Of the thirty-five participants with experience of ESS, thirty-one recounted their experiences in the scheme with the remaining four recounting experience of being in CSS. Those experiences can be grouped into three categories, those having wholly positive experience (n = 9), those with wholly negative experiences (n = 5) and those who have both positive and negative experiences of the scheme (n = 17). Fig. 5 and Fig. 6 show areas where participants had positive and negative experiences of ESS highlighting some of the words used to describe those experiences.

Figure 10: Summary of the positive experiences of the Environmental Stewardship Scheme.

Figure 11: summary of the negative experiences of the Environmental Stewardship Scheme.

A study of participant experiences of ESS starts to reveal barriers and opportunities to the uptake of CSS. In the next section we look at the three categories of farmer, those previously in AES, those currently in ESS and those who have moved on to CSS, exploring each pathway or intended pathway, identifying barriers and opportunities to the uptake of CSS.

4.3.3.1. Farmers previously in AES

Of the fifteen farmers leaving AES after previously being in ESS, only one had solely negative experiences with the scheme, three had solely positive things to say and the remaining eleven had mixed views. Despite many positive perceptions of ESS all have since left AES, some because of their experiences of ESS but most for reasons beyond their control. Experiences are positive when they correspond with the principal reasons for joining; ease of entry, goodness of fit and financial incentives are seen to be the areas in which the majority of participants recount positive experiences of the scheme (Table 1).

Table 4: Positive and negative experiences of the Environmental Stewardship Scheme as recounted by farmers previously in the scheme and actual and perceived barriers to the uptake of the Countryside Stewardship Scheme (figure in brackets represents the number of respondents).

Positive experience of ESS	Negative experience of ESS/reasons for leaving	Barriers to CSS (Actual)	Barriers to CSS (Perceived)
Goodness of fit	Lack of communication/interaction with NE/RPA/Defra	Low financial incentive	Not worth going in (word of mouth)
Financial incentive	Late payments	Less money more restrictions	Low financial incentive (word of mouth)
Positive or no inspections	Actual or threat of penalties	High transaction costs	Late payments (farming press)
Straightforward paperwork	Administrator/landlord issues	Complexity of paperwork and options	Scheme not working so farmers not joining (word of mouth)
Benefits to farm	No goodness of fit	No goodness of fit	Fits some farm types but not grazing livestock (word of mouth)
Simple points	High transaction costs	No choice/invitation only	Aimed at large farms (farming press)
Payments on time	No baseline/options unmeasurable	Risk of penalties	Assumed there is no change (no revisit to scheme after a number of years)
Positive relationship with NE	Options easily manipulated	No benefit to the farm	
Inter-agency cooperation	Conflict between UELS and HLS options	Focus moving from production to conservation	
Fitted with conservation principles	Too restrictive	Financial risk	
Recognition for effort	Mapping problems	Against personal good farmer principles	
Flexibility when unable to deliver on time	Unintended impacts of options	No continuity between schemes	
	Unable to get into HLS	Uncertainty over tenancy	
	No flexibility	No recognition	

No penalties	Mapping issues Administrative errors	Need private advisor/financial risk

Goodness of fit meant farmers could receive financial incentives without making any major changes to farming practice, “We were in ELS and UELS and we were getting £9k per year with this farm and the [………] land with not a lot of impact on our farming techniques, we didn’t have to change much”. (LFA grazing, male, 52) whilst, the ‘broad and shallow’ approach of the entry level scheme delivered options that provided benefits to the farm and enabled easy entry into the scheme, “The main benefits of being in the scheme are that the boundaries are in better shape so there’s the aesthetic look with the drystone walls”, (Dairy, male 40), “The ELS system itself is very good. We knew how many points per hectare we had to find so we had a starting point. Getting all those points was relatively easy”, (Arable, male, 49).

Negative experiences (see Table 1) of the scheme predominantly focus around payments and the risk of penalties and the frustrations surrounding the inability to communicate with the relevant authority, “The payments were usually late. And now, I think people are waiting years. People are going mad about it”, (LFA grazing, female), “On my farm’s scheme and if there was something wrong, we talked about it and I put it right whereas with them, you’re penalised, it’s either 3% or 5% off your single farm payment”, (LFA grazing, female, 67), “You cannot get an answer from the RPA or DEFRA. It goes round in circles. In three weeks, three months, or in some cases, three years later, you’ll get a reply”, (Lowland grazing, male, 65). Only two of the participants left AES solely due to their experiences with ESS, one did not re-apply after the first 5-years scheme due to the low financial incentives and risk of penalties, “I thought for the amount of money I was getting, the amount of paperwork involved and the fines involved if you get things wrong it just wasn’t worthwhile”, (LFA grazing, male, 55) and the other because it didn’t fit the farming system, “We went into ELS once the Farm Scheme finished. That sort of came to its end and we sort of, well we looked at the do’s and don’ts of what we had to do to reapply and it didn't sort of fit into our way of farming so we didn't bother with it", (LFA grazing, male, 48).

All others have either, enquired and decided not to apply or have applied and been refused entry as they were not in a target area. Of the thirteen participants who researched entry into CSS, one had a one-to-one interview with a NE advisor, six attended NE advisory meetings (some had one-to-one interviews following the meeting), four used private advisors and two conducted self-research. Table 1 lists the barriers to uptake. The top three barriers to uptake are linked to low financial incentives with twelve of the thirteen stating that the financial reward was either much less that they had received in ESS or that increased restrictions and administration burdens meant that the transactions costs on the farmer outweighed the financial incentive for participation.

"We were going to get; I think it was about £850 where we'd been getting £7000 before. And we had to do a lot more record keeping and book-keeping. It was a lot more onerous and time-consuming, so we just said it just wasn't worth it. Just wasn't worth it", (Lowland grazing, male, 65).

"The money that was on offer wasn't worth as much. £3000 a year, you know I can keep one extra cow. That'll give you £3000 a year for your milk income, a calf as well on top. It's just not enough money for our farming system", (Dairy, male, 32).

The complexity of the paperwork and the goodness of fit of CSS to farming systems also rate high as barriers to entry. The complex nature of the application system leads to an increased view that private advisors are required in order to reduce risk to entry but this increases the financial burden and risk on the farmer, "The amount of paperwork is a significant barrier, all it is doing is opening it up for a paid consultant. I'm not against consultants but this money is meant for farmers. It's not meant for consultants. It's meant for us to drop back into the business, to support it, to benefit the environment, not for a consultant to drive around in a £60,000 Range Rover because he can", (Arable, male, 49). Previous schemes have been seen to support farming systems and provide benefits to the farm whilst CSS is seen by some as shifting in focus from options which support the farming system to one which has a primary focus on conservation, "I couldn't see that it was going to be the same benefits as the previous scheme had. I don't think there were any capital works", (Dairy, male, 40); "You'd have had to take quite an area of land out of production really and we've not got a big enough farm to be able to carry on farming and take big areas out of production", (LFA grazing, male, 48).

Four of the thirteen participants, despite a desire to continue after many years in schemes, had no choice but to leave as there were either no options available to them or they were not in a target area. "I rung Defra up and said look we want to know what's happening with this scheme we're coming to the end of it we'll have to make some decisions over what we're going to do farming wise what's happening then they informed me then oh we're sorry Mr [.....] It's invitation only. We're only taking on the farms where we think it's necessary", (Lowland grazing, male, 38/80).

"Looking at it, it wasn't designed for a farm like this. It wouldn't have been worth going in, if we got in and it cost you to apply with no guarantee", (LFA grazing, male, 67).

There is very little difference between actual and perceived barriers (see table 1) to uptake. All participants who have left AES have personally looked at potential options to joining CSS and have come across actual barriers. Those who conducted initial enquires when CSS was first introduced in 2015 have been hindered from further enquires by the experiences of others shared by word of mouth and articles in the farming press.

4.3.3.2. Farmers currently in ESS

Eleven of the 42 participants of this study are currently in ESS. When asked what they plan to do when their current contract expires, 64% (n = 7) stated they would look at their eligibility for a CSS contract, 27% (n = 3) stated they were unsure and 9% (n = 1) stated they would leave AES. As contract end dates vary between participants there are variations in the levels at which the individual farmers have made enquiries into eligibility for entry into CSS. Table 2 shows where participants have encountered what they believe to be actual barriers to future entry into AES and where they perceive there to be potential barriers. Similarities exist between the actual and perceived barriers of this group and the actual barriers experienced by those previously in ESS. Of the seven stating they would look at their eligibility for CSS, only one (Arable, male, 57) is confident that they will gain entry into a scheme, albeit with a tweak to farming practice and one strongly feels that they will not be eligible due to their being no options available for their upland system (LFA grazing, female, 52).

Uncertainty over eligibility for CSS is revealed in the responses of the other five participants willing to look at CSS. Despite a strong desire to join for financial and environmental reasons, perceptions, formed through discussions with farmers currently in, or having been through the process, are that options will be limited, financial incentives will be low and that transaction costs, i.e., the initial financial and time burdens placed on the farmer, will be too high for the financial recompense. "If I am only going to get a couple of grand and the restrictions are on the whole farm and I'm only getting paid for one field then it's not going to be worth it", (Lowland grazing, male, 52).

"We have spoken to a few of the farmers that are a couple of years into some of those schemes ending, and they have looked at it and thought 'I don't think it's worth it' because the financial reward has got to last and all the hoops to jump through are still there", (LFA grazing, Male, 38).

Table 5: Farmer plans post-Environmental Stewardship Scheme and actual and perceived barriers to the uptake of the Countryside Stewardship Scheme

Future plan	Actual barrier	Perceived barriers
Look at CSS	Complex paperwork	Large farmers not interested
	Financial incentives	Too restrictive
	Risk of penalties	Late payments
	Late payments	No options available
	High transaction costs	Low financial incentives
	Too restrictive	More penalties, less money
	Too bureaucratic	High transaction costs
	Will need an advisor	No upland options
		Time delay between schemes
		Complex paperwork
		Low expectation of entry eligibility
		No benefit to farm (hedges etc.)
		Need for a private advisor

Unsure	Risk of penalties Complexity of paperwork Too restrictive	High transaction costs Low financial incentive Income foregone Unfair/unequal scheme Poor communication with agencies No control over options Financial risk Not worth it
No plan for CSS	Interference on farm No time for paperwork	Will encounter barriers Won't meet the requirements

These actual and perceived barriers and the lack of confidence in CSS meeting the main criteria for joining a scheme namely, benefits to the farm, forward thinking, environmental, financial and goodness of fit (Fig. 3) are likely indicators that farmers will move from AES towards a more production focused approach.

4.3.3.3. Farmers currently in CSS

Ten participants of this study were currently in CSS (2 x arable, 1 x dairy, 3 x LFA grazing and 4 x lowland grazing). Some had been in since it started in 2015 and others have more recent experiences. Their reasons for joining CSS at the end of their ESS contracts and their experiences of the schemes are discussed in the following sections.

4.3.3.3.1. Reasons for joining CSS

The main factor separating farmers opting to overcome barriers to CSS entry and participate, from those who left AES at the end of ESS is the 'passive/active adopter' principle (Morris and Potter, 1995). All ten farmers interviewed in the CSS category can be classed as 'active adopters'. Nine of the ten stated environmental or conservation reasons as a primary reason for joining and links to the environment can be seen across three of the four main reasons for joining CSS (goodness of fit, financial and environmental; Fig. 7). In the environmental category, strong environmental and conservation values are noted across all interviews with farmers feeling the need to give back to nature and preserve the habitat, including the cultural capital i.e., farm buildings, stone walls, of the landscape in which they farm, “It’s mainly, we want to farm in a way that we are giving a little bit back as well as using it to make a living”, (LFA grazing, female, 53).

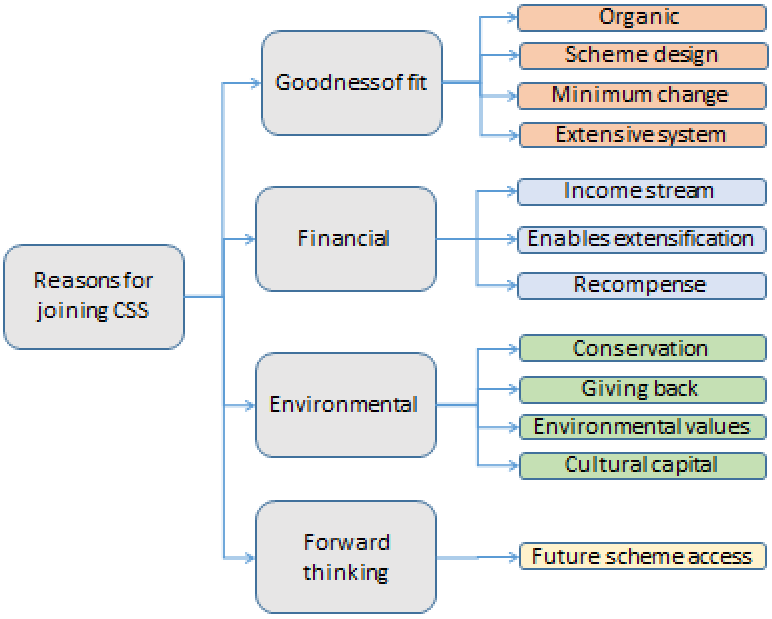


Figure 12: Reasons for joining a Countryside Stewardship Scheme following an Environmental Stewardship Scheme.

Environmental reasons are reflected in both the goodness of fit and financial categories with scheme design enabling organic and extensive farming to occur with minimal change to farming practice. Whilst financial incentives do provide an income stream, they are viewed as a means of recompense for extensive farming systems and the provision of environmental benefits rather than additional profit to the business.

“We couldn’t farm it like this to look after the grasses without payments, we would have to intensify and we don’t want to do that”, (LFA grazing, female, 33).

“Our main reason for going in was financial because it helps us to do conservation. We’ve been compensated for doing it”, (Lowland grazing, female, 58).

4.3.3.3.2. Experiences of CSS

One participant had wholly positive experiences of the scheme primarily due to the positive relationship they have with a NE advisor, “When the environmental stewardship was coming to an end, countryside stewardship – they came to us. It was because of the woods. The woods are in HLS, also we put wild bird mixtures strips around the farm, the hedge management still, restoration of walls”, (Lowland grazing, female, 69). One had only negative experiences due to the complexity of the paperwork and the need to utilise a private advisor and the difficulty they had in implementing the options, “CSS was more difficult. You have to get your head round the rotational elements and the fixed bits and where to put the fixed bits and which hedges counted because they were up against a road”, “It’s the first time ever that I’ve had to have external help in filling the form in”, (Arable, male, 68). All others have mixed experiences with the scheme (Table 3) with the number of negative experiences outweigh the positive. However, despite these negative experiences, none of the participants expressed a desire to leave the scheme; on the contrary, some have the view that it is worth being in despite issues and that the system is improving.

“That [main issues] was before we went in. I think it has been worth it”, (LFA grazing, female, 53).

“But I think now I’ve got a little bit of confidence it’s in the system and seems to be working”, (Dairy, male, 55).

Table 6: positive and negative experiences of the Countryside Stewardship Scheme

Farm type	Positive experience	Negative experience
Lowland grazing	Inspection Scheme management Scheme design Interaction with NE advisor Option choices	Inspections Complex paperwork Mapping Financial risk No flexibility Lack of confidence in Defra No interaction with agency Late payments No baseline Complicated process Scheme management difficult Lack of communication Lack of feedback
Arable	Benefit of private advisor	Complex paperwork Risk of penalties Mistrust of NE Scheme management difficult
LFA grazing	Benefit of private advisor Interaction with agencies Flexibility Thinks it's worth it	Late payments No continuity between schemes No continuity in advisors Slow response from NE Financial burden No value for money Lack of flexibility Paperwork Lack of interest at national level Interaction with agencies (NE) Low financial incentive Disagrees with options
Dairy	Improving system	Complicated process Financial risk Late payments

There are no significant differences in experiences of the scheme between farm types. All farm types note many of the same negative experiences occurring during the application process. The complexity of the paperwork and application process placed additional financial (through the need for a private advisor) and time burdens upon the farmer, "It cost us a fortune because he (advisor) was trying to ring them and we got charged each time. The bill was that bad that he knocked 25% off and it was still over £1,000" (LFA grazing, female, 33); "I found it quite hard, I measured my time, 20 hours solid work went into the application and that's like measuring things and taking photographs, taking soil samples sending off soil samples, writing out reports – and like I say writing out this wildlife report that didn't come to anything" (Dairy, Male, 55). However, the use of a private advisor is also seen as a positive by some participants as it removes these burdens and reduces risk, "I paid an agent to do the paperwork so it didn't arrive on my doorstep at all. But I still had to understand the codes and sort it out with him. He specialises in that sort of thing so we just paid him to do it", (LFA grazing, female, 53). Administrative issues continue after initial submission of the application form with processing delays often leading to farmers initiating options without sight of the actual contract, "I put in an application and it was 18 months before they formally accepted it, they wrote to me and said that my application had been lodged and that I would have to comply to all the rules and all that stuff and if you do all that we will backdate it", (Lowland grazing, male, 56) and this almost led to some not joining the scheme, "All we wanted was a yes or no and it got to the very last deadline date for signing up and we signed up without getting an answer over that but we had put a letter in that this was on condition and it still took weeks and weeks. We nearly didn't sign", (LFA grazing, female, 33).

Levels of interaction between the farmer and the administrating agency, in most cases NE, have significantly influenced perceptions of the scheme. Those experiencing proactive behaviours from advisors report positive experiences of the scheme and the administrative process, "He [the NE advisor] came and said well what do you think the problem is and we said well the biggest thing is the restricted grazing because that just doesn't work for us and he said well it is not working for us either because we are not getting the result we want so we will lift the restriction but he said just be sensible", (LFA grazing, female, 33); "But we've always found Natural England really helpful. And of the two, out of the RPA and Natural England, they're probably easier to deal with", (LFA grazing, female, 53). However, 50% of participants in this category report negative experiences with the administrating agency including a lack of face-to-face advisory visits, "The truth is they have no hands-on deck to come and do it in person and that's the challenge", (Lowland grazing, male, 56); a lack of communication regarding late payments, “I have been pushing them but no response because everyone is tied up with the May 15th deadline, nightmare, I wouldn’t have done it if I had known this. It is really impacting on the farms cash flow and making me cross, why should I do the rest of it”, (Lowland grazing, male); peer pressure, “Well I wasn’t happy but he [NE advisor] said he wanted me to go in so I did, he also said that when the next scheme comes around, I won’t be chucked to the bottom of the pile”, (LFA grazing, male, 59) and a lack of flexibility, “Even the inspector said ‘this is ridiculous. I’m going to try and see what I can do’. But they couldn’t because its EU rules, we had marked it as being there on the map, and it had to be there otherwise you had not followed through. There was a lack of flexibility”, (LFA grazing, female, 53).

The ‘active adopter’ nature of this group means that they can understand the problems faced by Defra, and the other administrating agencies, and are able to overcome barriers to delivery but their experiences have led to a lack of confidence, “You just accept that Defra has all that nonsense going on with itself and as long as they go away and do their stuff and don’t come back and penalise me they can call it black or white, I don’t care but it doesn’t instil confidence in the relationship with Defra and that is the whole point”, (Lowland grazing, male, 56) and in some cases mistrust, “People don’t want to bring Natural England onto the farm because they might start picking up things not to do with the scheme, they go back and report it and before you know it you have some big cheese coming down asking questions and that’s another 10-15% of your BPS and that’s why people don’t want them on their farm”, (Arable, male, 57).

4.3.3.4. Overcoming barriers to CSS uptake

Participants made a number of suggestions as to how barriers to joining CSS may be overcome (Fig. 8). Clear differences emerge between the suggestions made by those who have never been in schemes and those who have, and between the passive and active adopters of AES although there are areas of crossover. Those who have never been in a scheme suggest barriers to uptake of AES being reduced through the provision of knowledgeable local advisors and the implementation of a simple, localised scheme which benefits production and gives the farmer more control over delivery. The production-focused attitude of this group means that advisors must, "Understand both sides of the problems of farming as well as the environmental side" (Dairy, male, 65) and be prepared to "Come in and having a walk round the farm spending a couple of hours sitting down like we're doing now and saying right I've had a think, have you thought about this, have you thought about that, what about this one", (Lowland grazing, male, 30's).

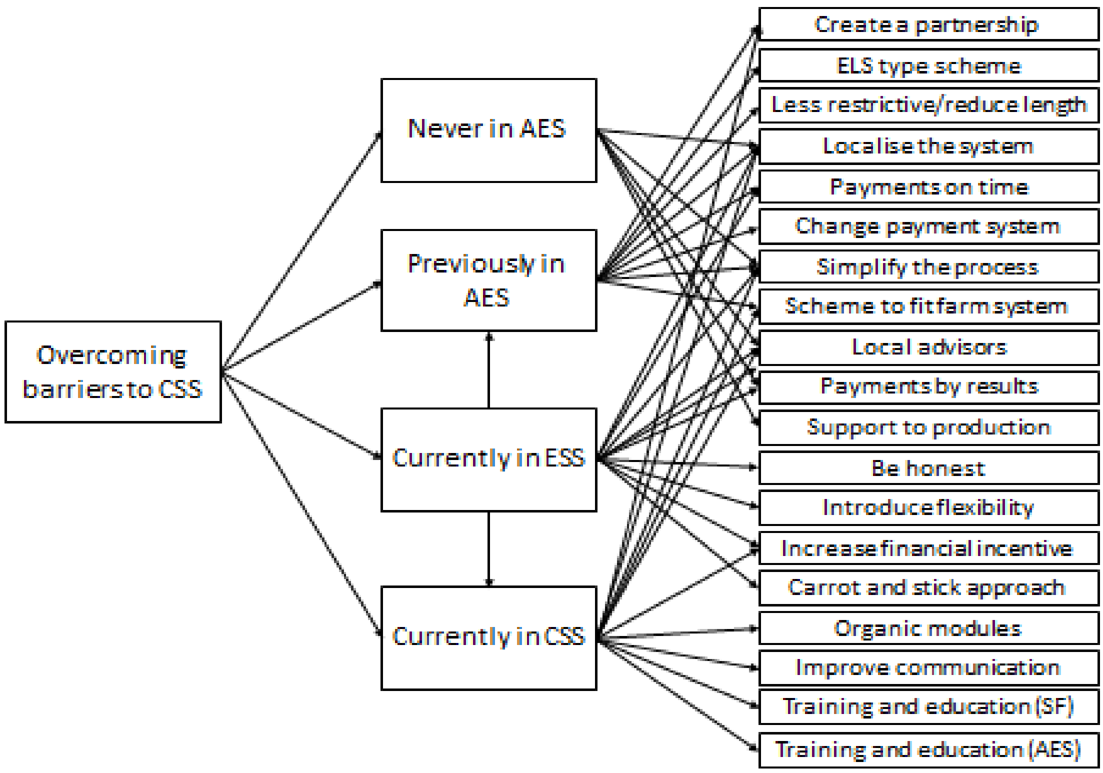


Figure 13: Overcoming barriers to the uptake of the Countryside Stewardship Scheme

This group feels detached from national schemes, arguing for AES management and administration to be transferred to the National Park Authority, "Just hand the power and the money back to the national parks. I don't know, I just can't believe they just haven't. They're too far away from us, aren't they? They're not on the spot like national parks. I know they're working with European law and all that, but it really does just need to go back to the national parks", (Lowland grazing, male, 54) and for farmers to have more control over the delivery of options, "As a farmer, my voice is not heard with regard to habitats. Because of the way we have farmed, what we needed to do we didn't come into it. If I had more of a say in the management of land in a scheme, I would be much more likely to be interested", (Dairy, male, 65).

The localisation of AES and the simplification of the process were the only two suggestions mentioned by participants in all categories. 50% (n = 21) of respondents promote the use of local advisors or a shift to NP management of schemes due to differences in habitat, "The problems that they've got down there are different to what we've got up on the moors here. And that'll be the same – the difference over in the Lake District. And it really needs to be a bit more localised" (Arable, male, 49); ease of access, "If you've got somebody that you can get hold off that's easy to talk to that knows the area, knows us and we know them and we can get on with then that's a lot better", (Lowland grazing, male, 55) and a perceived increase in communication and interest, "I would much prefer it if NP officers came onto the farm , I'd love to do the walk with them, there would be a 2-way conversation and it is the opportunity for that officer be it NE or NP to provide encouragement like, 'did you know that you are now one of 50 farmers doing this and the good news is that we have seen more orchids than ever before', I don't know, just encourage me, incentivise me", (Lowland grazing, male, age not supplied). The simplification of the scheme begins with the paperwork and application process, "I think that the application processes need to be streamlined and simplified", (Lowland grazing, female, age not supplied) which needs to provide information to the farmer as to their options, "If it was something really straightforward telling us what we could and couldn't do, we might go find out more detail and I think that's what you need. I suppose headlines and then you can find out the next bit if you need to", (Arable, male, 67). It then extends into the need for improved advisory services, "A bit of professional advice or someone who has actually got a thorough knowledge of the scheme if you've not got the time or motivation to actually do it yourself. I'm convinced I probably could get my head round it if that was my primary focus", (Lowland grazing, male, 65) and clear objective, "I think if it was simple enough to get. If the government said 'right, here's a simple thing, you put a field down to your beet crop or whatever or your wild birds, and we give you a suitable amount of money to cover your expenses of putting it in plus a little bit because you want a profit', then I'd be ok. We'd go with that. It's simple enough", (Arable, male, 43).

Passive adopters, namely those previously in AES and some of those in ESS, support the localisation and simplification of AES, but some suggestions made by these groups could easily be implemented thereby reducing barriers to uptake. For example, this can include the need to develop a partnership between the farmer and the scheme provider, "Although it [NP farm scheme] was farmer-led in some ways, it was a partnership. Whereas with the entry-level thing, you signed up and you weren't in any partnership with anybody, RPA gave you £1200 a year or something, thank you very much and I will carry on but that was pretty much it", (Lowland grazing, male, 66) and making payments on time. Suggestions to move back to a less restrictive, ELS type approach indicates a preference for the broad and shallow approach to AES over the more targeted approach taken by CSS. One suggestion supports the 'payments for public goods approach' through a move away from income foregone, "forget about the income foregone system. This income foregone is crazy because we are all pleading that we are not getting any income so we are not going to be able to put in for much money, are we? Let's get paid what we are worth. We need to be paid what it costs to run these spots, but these spots can offer so much, we can provide an environment for everyone to see and enjoy and we can provide food as well. These farms can produce, without impinging on the environment", (Lowland grazing, male, 66).

Active adopters also support a move to a simpler localised scheme but suggestions made by this group demonstrate a willingness to engage and find compromise through improved communication channels, "The main thing would be if you could just get your answers. I mean with our hay field the advisor copied me in and it was just message after message asking them to get in touch and tell us what has happened", (LFA grazing, female, 33) and the provision of training and advice on sustainable farming (SF), "We have the autumn calvers and the spring calvers and at the moment, we are finding it really hard to keep the autumn calvers' weight on. And it would be a bit of education about that. So, about things that could help with the money so as you don't have to rely on these – and also marketing of your beasts", (LFA grazing, female, 53) and the delivery of environmental goods and the government narrative, "I totally agree that things are not explained enough and it would be good, it is all part of the story that needs to be told. It would make a huge difference to me if they were. I'd love to be able to quantify a bit more the things that I think are making me feel good. I think the prescriptive nature of schemes puts them off rather than encourage", (Lowland grazing, male).

4.3.3.5. The role of the NYMNPA in overcoming barriers to CSS uptake

Participants were asked to explain what role they thought the NYMNPA had to play in breaking down barriers to CSS uptake and expand upon the suggestion to localise AES. Location (inside the NP) and experience of previous schemes (NYMFS) have positively influenced perceptions on how an AES scheme could and should be run. Whilst 43% of the suggestions are linked to the NYMNPA's role in breaking down barriers to the uptake of CSS, the majority of suggestions (58%) recommend a move away from a national scheme towards a NYMNPA-led scheme (Fig. 9).

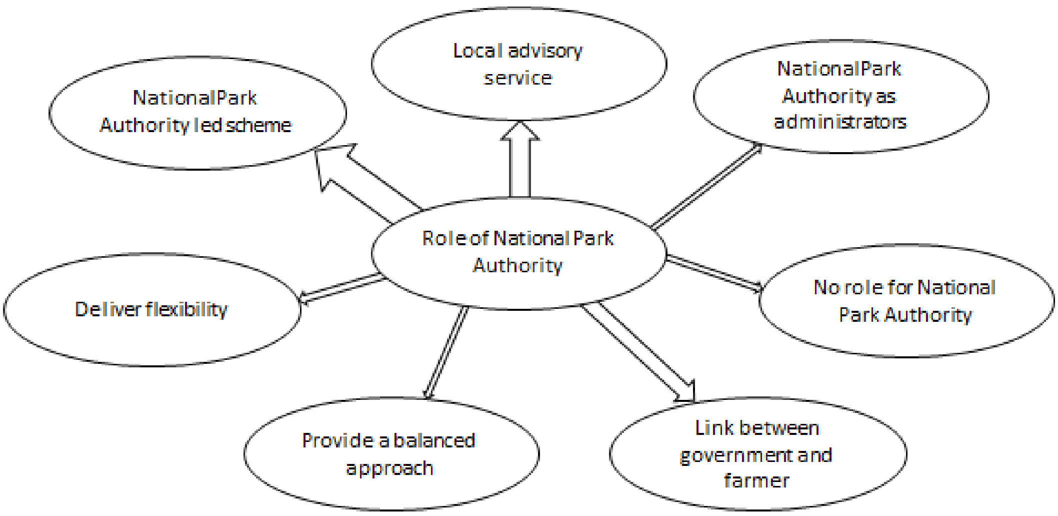


Figure 14: The role of the North York Moors National Park Authority in overcoming barriers to the uptake of the Countryside Stewardship Scheme

A belief that a NYMNPA-led scheme would have greater uptake than current ESS and CSS is linked to personal experience with NP staff and an opinion that the NPA has a responsibility to preserve the natural and cultural heritage of the park. Staff are seen as having good local knowledge, "The National

Parks know their local area which helps tremendously, they work with the local area and what is needed in that area, what needs conserving, what needs looking after, you know. When they've been out on-site visits, they'll know and be finding out how different farms are but somebody down in Leeds telling us what to do up here won't know the difference between that garden and that garden will they?", (LFA grazing, male, 48) and experience, "I think the national park have a leading role here. I mean, years ago they had a farm scheme which was the envy. I mean, we were never in it because we weren't in the right area at the time, but friends that were in it said it was absolutely marvellous. You'd got a co-ordinator and you had a point of contact and a point of focus. You could talk to somebody. You could pick the phone up and you got the same person every time. Saying 'I'm having a little bit of a problem with – what do you advise?' and you could get an answer", (Lowland grazing, male, 65).

The NP staff localise the scheme, building confidence in the farming community and making them feel part of the narrative, "bodies like the national park should have a chance to get us into these schemes because I think there would be a big uptake. You need to have confidence in whoever is supervising it and in charge of it and if it's just a faceless somebody sat in an office down south or wherever who doesn't have any real experience of areas like this or the countryside. Whereas, there's loads of you at the national park, you are passionate about this area, aren't you", (LFA grazing, female, 67). With this confidence comes a belief that that the NYMNPA are best placed to tackle the challenges faced by communities living within the park boundaries, "I think National Park have got to get involved because the countryside hasn't developed like it has naturally has it. It's been like these moors have been kept and they've got like they are. You just have to see the ones that aren't kept there's two or three have had big fires haven't they, Ilkley Moor has had a big fire on it and destroyed it all. Push for these stone walls to be done and like the moors to be kept properly instead of just going back to rack and ruin", (LFA grazing, male, 64).

Whilst the majority of participants show a preference towards a local scheme there are an equal number of participants suggesting a compromise through the provision of local advisors or go-betweens (n = 21, Fig. 9). The NYMNPA would provide a local face-to-the national scheme, working closely with the farmer to give advice and assistance on administration, “You could have somebody that came out and filled out the paperwork, like we said earlier, somebody that knows the scheme. Not necessarily do the paperwork but sit down with you and say ‘yes, you can claim this, you can claim that’ and ‘look at this’ and ‘have you thought of that’, (Dairy, male, 51); option uptake, “If the national park was to do something, having somebody who’d come out and talk things through regarding your options and how best to make your patch do the business, then that would be a handy useful way of doing it”, (Arable, male, 43) and sustainable agriculture, “I would quite like advice on farming. Are we farming to the best ecological advantage to the park as possible? Being inside the park, obviously the environmental considerations are a little bit higher. If you want to put buildings up and things, the rules are obviously stricter and potentially more costly. We do have responsibility towards the park. This is a beautiful area and you’ve got this conflict; you have to make a living and equally you’ve got to be careful you’re not totally damaging the environment. It’s getting that balance right”, (Dairy, male, 64). The NPA could then act as a link between the farmer and the government, “There is definitely a role. I see the NP as a link between the farmer and the government. I feel that in the farmer/government link there is something missing there. If we could have the NP in the middle, I reckon that would be a big help”, (Lowland grazing, male, 66) providing advice to the government on goodness of fit of schemes to the national park, “probably the useful thing the national park could do is lobbying really. For how these schemes look and make sure that the scheme as a whole fits the national park. You can’t tailor one scheme for sort of the whole country, but at least be shouting for this area and having options in there or options available that match the requirements of this area”, (Dairy, male, 40) and, through access to the Defra system, ease the administrative burden to both the farmer and Defra, “Someone could come who would be linked in to Defra’s system, we could go through the application, help fill it and check that it was okay making sure that there were no glitches in the system and in effect they could push the button and okay it. They would be my interface”, (Lowland grazing, male, 56) adding a level of flexibility into the system, “I think the NP could be those people that could be the ones to deliver that flexibility in that they would have a licence to enter Defra's system and amend an application", (Lowland grazing, male, 56).

The suggestion to localise advisory services and provide local links into the national system is one which is potentially transferable to other areas, "That could happen on the Wolds, the Lincolnshire Wolds, us, the Peaks, the Lakes, the Pennines, the Vale of York, you know it could all be segmented and surely run a lot more smoothly. You get these hill areas that are more or less similar farming areas, you get Ryedale, the Vale of Pickering similar, the Vale of York, you know and then the people who are running it are used to dealing with us, those problems, you know what's going to be coming", (Dairy, male, 53) and across the national parks, "It's possible if you took all the national parks in the country and said right, we'll have slightly different rules within all the national parks. They might say we'll do more for stone walling because obviously national parks have lots of stone walls, they could say we want the farms to have really good assistance with stone walling and that would be good. So yes, it is an option", (Arable, male, 68).

In summary, all participants in this study see a role for National Park Authorities in future AES management and delivery, be it as the primary deliverer of AES or as a link between the government and the farmer in both advisory and administrative roles.

5. Impact of no entry into CSS

The greatest risk facing Defra and the NP is the impact that a move of farmers out of AES will have on the cultural and environment landscapes. Two of the farmers interviewed discussed how they have had no choice but to revert land, which has been in AES for approx. 20 years, back into production, "If that's how they value the environment, that they are willing to just let it go when we have looked after it for nearly 20 years and they are happy to let it go, then that's what we will do. I've got to make it produce, if the environment schemes are not paying then I have got to make the farm pay. So, we are now reseeding fields that we never would have done", (LFA grazing, Male, 52) and this is having a marked impact on biodiversity, "Since coming out of it and we have put the land back in to production and stuff like that obviously there is less habitat for them (birds), there's not many lapwings about we are down. With winter stubbles we used to have flocks of them", (Lowland grazing, male, 58).

6. Conclusions

In conclusion, we show that the farmer's decision to participate, or not, is influenced, not by an individual factor, but by a complex mix of personal, family and farm business factors. We found the primary reasons for participation in AES, categorised into five main groups, (i) benefits to the farm, (ii) forward thinking, (iii) environmental, (iv) financial, and (v) goodness of fit. These were also being linked into the main reasons for people leaving ESS and not joining CSS. All participants had positive experiences of early schemes, both national and NPA-led schemes, but negative experiences of AES started to appear during participation in ESS. Negative experiences of the scheme predominantly focus around payments and the risk of penalties and the frustrations surrounding the inability to communicate with the relevant authority. However, there were also many positive perceptions, especially of UELS which is a broad and narrow scheme. All farmers interviewed in the CSS category can be classed as 'active adopters' with the majority citing environmental or conservation reasons as a primary reason for joining CSS. Again, however, not all experiences of the scheme have been positive and these negative experiences, when relayed to other farmers contribute to barriers to uptake. Participants made a number of suggestions as to how barriers to joining CSS may be overcome with the primary suggestions being to localise and simplify the scheme. The majority of suggestions to localise AES were not directly linked to CSS, opting instead for a complete shift in the way AES is delivered with NPA's taking control of the administration and management of schemes. It is clear from our findings that farmers see NPA's having a major role to play in the delivery of future AES be it as the lead in delivery or in an advisory role acting as the link between the farmer and the government. A failure to move from ESS into CSS poses a major threat to habitat and biodiversity, not only within the NP but across the whole of England. This research interviewed a relatively small sample of farmers within the NYMNP and the responses are reflective of the surroundings in which these farmers conduct business. Further research would be required to determine farmer perceptions of CSS in other national parks and in areas outside of national park boundaries.

Acknowledgements

The NYMNPA and the researchers would like to thank all participants for the giving of their time to contribute to this study. Special thanks go to Rachel Smith, Judith Seaton and Ann Stafford for their assistance with transcriptions.

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Appendix 3

Supplementary material for Chapter 7

Importance of building and linking social capital in adapting to changes in agricultural policy

David Arnott, David R. Chadwick, Sophie Wynne-Jones, Norman Dandy, David L. Jones

Supplementary Information

Table S1: Description of the main environment groups that participants in the non-agricultural category hold memberships.

Group	Description	Link
Yorkshire Dales National Park Pilot Scheme	A total of 19 farmers have entered bits of land into a "Results-Based Agricultural Payment Scheme". They are being paid according to results, which means there are no prescriptions to follow on cutting dates. The principle is straightforward: the more species-rich the meadow, the higher the payment to the farmer. 'Payment by results' – Refers to publicly-funded schemes that reward farmers for achieving environmental improvements, rather than for following detailed sets of rules and regulations.	https://www.yorkshiredales.org.uk/about/national-park-management-plan/c-wildlife/objective-c4/
Yorkshire Dales flood facilitation management group	In 2018/19, there were five Natural Flood Management Facilitation Fund projects running across the National Park, working with groups of farmers to identify opportunities to introduce natural flood management measures.	https://www.yorkshiredales.org.uk/about/national-park-management-plan/d-climate-change/objective-d5/
The Rivers Trust	The Rivers Trust is the umbrella organisation for 60 local member Trusts, they are the only group of environmental charities in the UK and Ireland, dedicated to protecting and improving river environments for the benefit of people and wildlife.	https://www.theriverstrust.org/who-we-are/about-us/
The Wildlife Trusts	The Wildlife Trusts is a grassroots movement of people from a wide range of backgrounds and all walks of life, who believe that we need nature and nature needs us. They have more than 850,000 members, 38,000 volunteers, 2,000 staff and 600 trustees.	https://www.wildlifetrusts.org/about-us
The National Trust	Europe's largest conservation charity, they look after nature, beauty and history for the nation to enjoy. Thanks to the millions of members, volunteers and staff that support them they be able to care for the miles of coastline, woodlands, countryside and the hundreds of historic buildings, gardens and precious collections under their protection.	https://www.nationaltrust.org.uk/features/about-the-national-trust
The RSPB	The largest nature conservation charity in the UK, consistently delivering successful conservation, forging powerful new partnerships with other organisations and inspiring others to stand up and give nature the home it deserves.	https://www.rspb.org.uk/about-the-rspb/

Fferm Ifan	Fferm Ifan is a group of 11 tenant farmers based on the Ysbyty Ifan estate. The farmers have grazing rights to the Migneint, one of the largest areas of blanket bog in Wales, which is designated as a Site of Special Scientific Interest, Special Area of Conservation and Special Protection Area. The group are working on a landscape scale scheme to manage natural resources more sustainably and effectively, funded by the Welsh Government's Sustainable Management Scheme (SMS).	https://www.nationaltrust.org.uk/features/fferm-ifan

S1. An example of the questionnaire used during farmer interviews

Identifying social capital types between farmer groups

Interview number–

Introduction

1. Introduce interviewer, explain research project and aim of interview.

2. Ask for permission to record interview.

3. Explain data protection and anonymity.

4. Explain what will happen with results of interviews.

Demographics

a) Farm type:

b) Farm Size:

c) Gender:

d) Age:

e) Type of AES: Can you tell me about any AES that you are involved with? HNVF group:

Can you tell me what you do above and beyond that required of an AES?

f) Diversification: Can you tell me about any diversification activities that you are involved in?

Network and social capital

Groups

1) I would like to start by asking you about the groups or organisations, networks, associations, outside of family networks, to which you belong. These could be formally organised groups e.g., Farmers groups, union, traders' association, production cooperatives or machine rings or informal groups who get together regularly to do an activity or talk about things. E.g., village committee, sports group, club, informal cooperatives.

Can you tell me about the groups you belong to, how many and the type?

2) Of the groups to which you belong which two, are the most important and why?

3) Can you tell me about your involvement with the groups e.g., how many times a year do you participate in group activity?

4) Can you tell me how you became a member of these groups?

5) What do you think are the main benefit of being in these groups?

6) Can you tell me about the other members of the groups e.g., are they from a similar occupation or educational background as you?

7) Can you tell me about membership levels in the groups e.g., is membership in the group declining (a), remaining the same (b), or increasing (c) and why you think this may be the case?

8) Can you tell me about your group's interactions with other groups with similar goals e.g., how often and when?

9) Can you tell me about your group's interaction with other groups with different goals?

10) How are your groups funded?

11) Can you tell me who originally founded the group?

Networks

12) Can you tell me about your immediate network e.g., how many close friends do you have? (These are people you feel at ease with, can talk to about private matters, or call for help).

13) If you suddenly needed help to see you through a short-term emergency e.g., delay in BPS, AES payments, are there people beyond your immediate household and close relatives to whom you could turn to? (ask for an example).

14) How do you get on with your neighbours? If you suddenly had to go away for a day or two, could you count on them to take care of your farm?

15) If you suddenly faced a long-term emergency such as an injury or a harvest failure/BSE crisis, how many people beyond your immediate household could you turn to who would be willing to assist you? (Can they provide an example).

Trust and solidarity

In every community, some people get along with others and trust each other, while other people do not. Now, I would like to talk to you about trust and solidarity.

16) Generally speaking, would you say that most people in your community can be trusted or that you can't be too careful in dealing with people? (Ask participant to expand upon the answer)

17) In general, do you agree or disagree with the following statements?

1 = agree strongly, 2 = agree somewhat, 3 = neither agree or disagree, 4 = disagree somewhat, 5 = disagree strongly.

1. Most people in this community are willing to help if you need it:

2. In this community you have to be alert or someone will take advantage of you:

Ask participant to explain the responses using examples

18) How much do you trust?

1. Local government officials:

2. Central government officials:

Ask participant to explain the responses using examples

19) If a community project does not directly benefit you but has benefits for many others in the community, would you contribute time or money to the project?

1. Time:

2. Money:

Ask participant to explain the responses using examples

Collective action and cooperation

20) In the last 12 months, have you participated in any communal activity where people came together to do some work for the benefit of the community?

Can you give me an example of when or tell me why this has not happened?

How many times in the last 12 months have you participated in communal activity?

21) If there was a problem affecting the whole community, how likely is it that people will cooperate to help solve the problem?

Can you give me an example of when this has happened or tell me why people will not cooperate?

Information and communication

22) What are your three main sources of information about what the government is doing (such as Brexit, subsidies, policy change, etc)?

23) What are the three most important sources of market information (such as jobs, process of livestock or crops)? How often do you access the internet?

24) How has access to the internet impacted upon your business?

Social cohesion and inclusion

27) There are often differences between people living and working in the same community. For example, differences in wealth, income, social status, land-use, access to land, age or sex. Can you tell me how differences between people impact upon your community?

28) Do any of these differences cause problems and if so, which differences cause the most problems?

30) How many times in the past month have you got together with people to have food or drinks, either in their home or in a public place?

Can you tell me a bit about the people you met with e.g., are they from a different occupation of social status than you?

31) In general, how safe from crime and violence do you feel when you are at home and why?

Empowerment and political action

33) In general, how happy do you consider yourself to be?

34) Do you feel you have the power to make important decisions that change the course of your life?

Ask respondent to expand upon the answer

35) In the past 12 months have you, individually, or as part of your community, petitioned the government or completed a consultation paper that may lead to benefits for the community?

If yes, ask participant to give an example

36) Did you vote in the EU referendum?

37) Did you vote in the last general election?

Additional questions

38) (Nature friendly farming group) - What were your main motivating factors to farm in a nature friendly way?

39) (AES group) – What were your main motivating factors to join an AES?

41) (Non-AES group) What are the main barriers preventing you from joining an AES?

42) On a scale of 1 – 4, do you think Brexit and changes to the payment scheme will impact your business? 1 = Significantly, 2 = slightly, 3 = unsure and 4 = not at all doesn’t apply to me.

43) How will you change your business practices to cope with future challenges arising from Brexit?

44) What are the pros/cons to working with other people/groups within and outside of your immediate network?

45) Would you be prepared to increase the number and type of people e.g., voluntary sector organisations, farm advisors, researchers, etc in your social network to increase farm viability?

46) If yes, what do you think the benefits of doing so would be.

47) If no, what are the disadvantages of doing so?

That brings the interview to an end, thank you for your time

SI 2, The World Bank six dimensions of social capital

Groups and Networks. This is the category most commonly associated with social capital. The questions here consider the nature and extent of a household member's participation in various types of social organizations and informal networks, and the range of contributions that one gives and receives from them. It also considers the diversity of a given group's membership, how its leadership is selected, and how one's involvement has changed over time.

Trust and Solidarity. In addition to the canonical trust question asked in a remarkable number of cross-national surveys, this category seeks to procure data on trust towards neighbours, key service providers, and strangers, and how these perceptions have changed over time.

Collective Action and Cooperation. This category explores whether and how household members have worked with others in their community on joint projects and/or in response to a crisis. It also considers the consequences of violating community expectations regarding participation.

Information and Communication. Access to information is being increasingly recognized as central to helping poor communities have a stronger voice in matters affecting their well-being. This category of questions explores the ways and means by which poor households receive information regarding market conditions and public services, and the extent their access to communications infrastructure.

Social Cohesion and Inclusion. "Communities" are not single entities, but rather are characterized by various forms of division and difference that can lead to conflict. Questions in this category seek to identify the nature and extent of these differences, the mechanisms by which they are managed, and which groups are excluded from key public services. Questions pertaining to everyday forms of social interaction are also considered.

Empowerment and Political Action. Individuals are “empowered” to the extent they have a measure of control over institutions and processes directly affecting their well-being. The questions in this section explore household members’ sense of happiness, personal efficacy, and capacity to influence both local events and broader political outcomes.

Agricultural/land-based Groups
- Breed associations,
- National Farmers Unions (NFU's),
- Farmer networks,
- Grazing associations,
- Trade support groups and
- young farmers groups

Non-agricultural /environmental groups
- RSPB,
- Wildlife and National Trust,
- Renewable energy group,
- Flood facilitation management group,
- Sustainable Management Schemes (National parks)

Political/community groups
- Global Justice Now,
- The Labour Party,
- The Country Land and Business Association,
- National Park Authorities,
- Parish and village councils,

Social/church groups
- Rugby/football clubs,
- Cycling/walking groups
- Bowling groups,
- Church groups,
- Shooting syndicate/hunt group
- Book club

Figure SI. Categories of farmer social groups with examples of group type for each category.

Appendix 4

Supplementary material for Chapter 8

Exploring viable upland farming systems compatible with UK net zero carbon targets

David Arnott, David R. Chadwick, David L. Jones, David Styles.

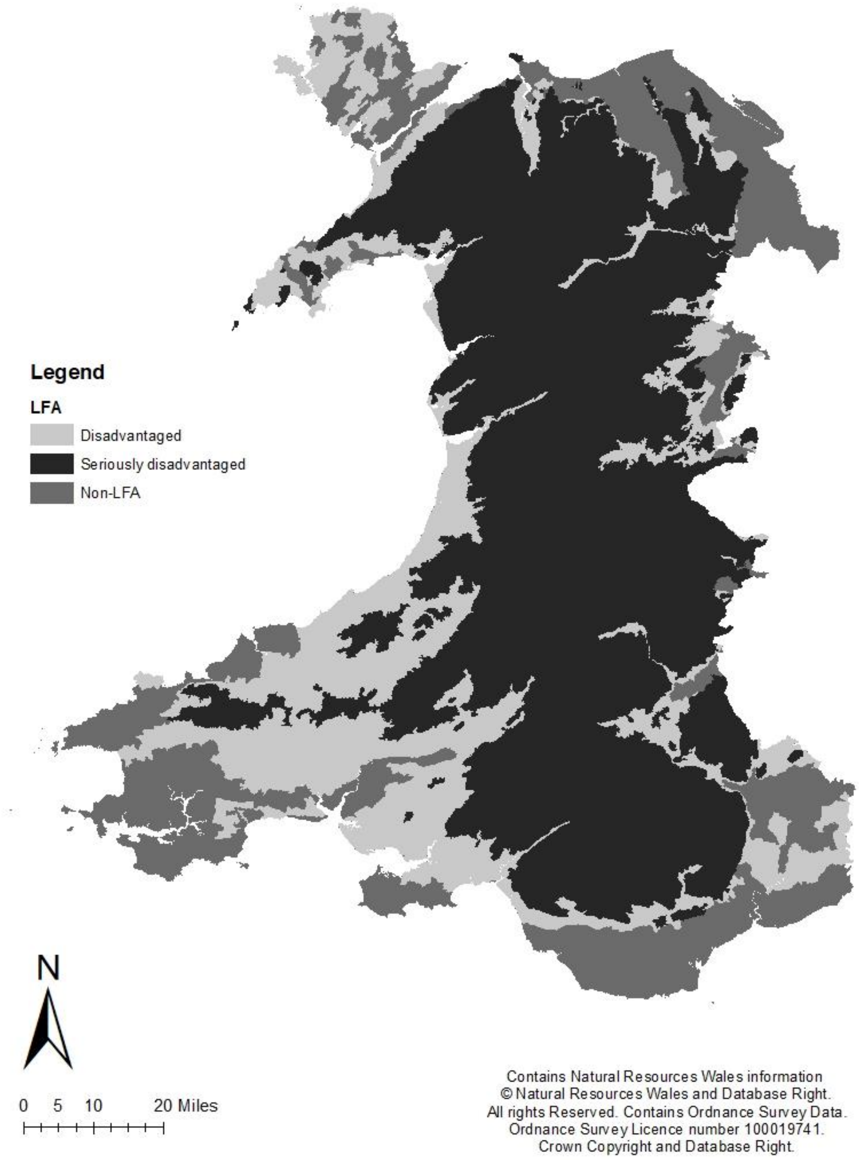

Figure SF1. The Less Favoured Area (LFA; Severely Disadvantaged and disadvantaged) and non-LFA land classifications in Wales.

ST7. Welsh greenhouse gas (GHG) inventory by sector for the base year (1990) and 2017 showing the 80 and 95% 2050 Net Zero reduction targets from the base year (Thistlewaite et *al., 2020). *All emission estimates include the 6 Kyoto greenhouse gases in kilotonnes of CO_2 equivalent.*

Sector	Base year*	Base year -80%	Base year -95%	2017 emissions	Reduction to meet 80% target	Reduction to meet 95% target
Measurement	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e	kt CO_2e
Agriculture	6,322	1264	316	5,613	4,349	5,297
Business	13,532	2706	677	8,750	6,044	8,073
Energy supply	18,013	3603	901	14,377	10,774	13,476
Industrial processes	2,800	560	140	1,956	1,396	1,816
Land use change	-386			-395		
Public	771	154	39	332	178	293
Residential	4,987	997	249	3,617	2,620	3,368
Transport	6,411	1282	321	6,240	4,958	5,919
Waste management	3,280	656	164	1,257	601	1,093
Total Emissions	55,730	11146	2787	41,747	30,601	38,961

Table ST2. Framework used to create seriously disadvantaged, disadvantaged and lowland farm profiles to generate carbon footprints using the AgRECalc carbon footprint tool.

Farm profile **Farmed area**	**Farm typology**								
SDA	SDF (None; receive no basic payment)								
	SDF (Average farm across all BPS payment categories)								
DA	DF (None; receive no basic payment)								
	DF (Average farm across all BPS payment categories)								
Lowland	LF (None; receive no basic payment)								
	LF (Average farm across all BPS payment categories)								
	Farm structure								
	Permanent pasture	Rough grazing	New grass	Cereals	Stockfeed	Other crops	Woodland (Broadleaf)	Woodland (Conifer)	Other use (Buildings, yards roads
	Forage type								
	Rough grazing	Pasture grazing	Silage and graze	Hay and graze	Kale/stubble turnips/swedes, etc	Wholecrop cereals	Forage maize		
	Fertiliser usage								
	Total quantity (tonne)	% N	% P	% K					
	Crop Production				**Crop Use**				
	Rough/pasture/ silage/hay, fodder crops	% crop removed	% harvested dry matter	Harvested or forage yield (t/ha)	Sold (t)	Fed or used for bedding (t)			

	Crop allocated to livestock							
	Rough/pasture/ silage/hay, fodder crops	% allocated to sheep	% allocated to cattle					
	Farming enterprise							
SDA/DA	**Beef enterprise type**	**System type**						
	Spring calf hill suckler cows	Breeder/finisher						
	Cattle class							
	Suckler cow	Bull	Heifer 24-36 month	Heifer 12-24 month	Heifer 0-12 month	Steer 24-36 month	Steer 12-24 month	Steer 0-12 month
Lowland	**Beef Enterprise type**	**System type**						
	Spring calf lowland suckler cows	Breeder/store						
	Cattle class							
	Suckler cow	Bull	Heifer 24-36 month	Heifer 12-24 month	Heifer 0-12 month	Steer 24-36 month	Steer 12-24 month	Steer 0-12 month
SDA/DA	**Sheep enterprise type**	**System type**						
	Extensive hill ewe flock	Store/finisher	Hoggs (Ewe lamb for breeding 6-12 months)	Gimmers (Ewe lamb for breeding >12 months)	Shearlings (Tups/Rams for breeding 6-12 months)	Lamb		
	Sheep class							
	Ewes	Tups/rams						
Lowland	**Sheep enterprise type**	**System type**						
	Crossbred ewe flock	Store/finisher	Hoggs (Ewe lamb for breeding 6-12 months)	Gimmers (Ewe lamb for breeding >12 months)	Shearlings (Tups/Rams for breeding 6-12 months)	Lamb		
	Sheep class							
	Ewes	Tups/rams	Average number of livestock over 12-month period					
	Livestock numbers and weight							

Cattle	Average liveweight (kg)	Average liveweight (kg) at 1 yr or at slaughter if before 1 yr	Average liveweight (kg)	Average number of livestock over 12-month period				
Sheep	Average liveweight (kg) at weaning							
Purchases, sales and deaths								
Purchases		**Sales**		**Deaths**				
Number of purchases	Average liveweight (kg)	Number of sales	Average liveweight (kg)	Number of deaths				
Other sales for sheep	Wool (kg)							
Cattle performance								
Age of first calving (months)	Calving	Calf birth weight (kg)	Slaughter or sale age (months)	Average daily liveweight gain (kg/hd/d)				
Sheep performance								
Lambing %	Lambing % singles	Lambing % twins	Lambing % triplet					
Manure management system								
% of time at grass (field or on hill) or housed								
in-bye fields %	Hill ground %	Liquid slurry %	Solid storage (FYM) %	Pit storage (slats) %	Deep bedding %			
Purchased bedding								
Straw	Sawdust/woodchip							
Purchased feed used (tonnes)								
Hay	Grass silage	Forage crops	Grain	Soya	Pellets	Nuts		
Electricity and fuel								
Electricity (kWh)	Red diesel (ltrs)	White diesel (ltrs)	Petrol (ltrs)	Kerosene (ltrs)	LPG (ltrs)	Mains gas (kWh)	Coal (kg)	Renewable energy
Waste								

Waste plastic / packaging (kg)	
Transport	
Distance travelled using external haulage (km)	
Water	
Water use (ltrs)	

9.3. Case study 1

CS1 was a typical mixed livestock Welsh Hill farm mainly DA with some SDA land, the majority owned and some tenanted, some of which was fertilised to produce silage. Production costs outweighed income from sales and the farm was heavily reliant on BPS payments. The farmer is over retirement age and realises that income from livestock is not enough to ensure farm viability and therefore decided to entry into the Glastir Woodland Scheme (Welsh Government, 2020b) where 50,000 trees, a mixture of broadleaf, such as oak and birch, and conifer trees, were planted on ~18 ha of the farm. Cattle were removed and sheep numbers reduced. Sheep live outdoors all year round, rented land was given up and silage land was reverted to permanent pasture, negating the need for fertiliser. Tree planting provides maintenance income for twelve years, and potential future income from thinning (after approx. 20 years) and main harvests (after approx. 40 years) or access to the carbon capture market (AgriCarbon, 2020). Combined with reduced input costs, this increases the farms' chance of remaining viable although the farmer still cautions "that without BPS payment they would struggle to survive". The farmer is prepared to enter more of the farm into schemes which pay 'public money for public goods' such as flood alleviation.

9.4. Case Study 2

This farm, previously a traditional Yorkshire mixed livestock hill farm with cattle and a reasonably high quantity of Swaledale sheep, is three times the size of CS1. The nature of the land on the farmer meant that this farmer had already had a no fertiliser approach. The sheep enterprise was found to be a significant drain on farm income, so numbers were reduced and traditional cattle breeds were introduced in a move towards a more economically sustainable, low intensity conservation grazing approach. Livestock graze outside all year round without the use of grain-based feeds, maturing slowly at a natural rate. The potential for large scale carbon sequestration through trees is limited. However, there was an opportunity to improve and increased the condition of traditional hay meadows on the farm and a low input, conservation grazing approach has improved flora and fauna biodiversity and provided natural habitat for many species. Changes to farming practice reduced input costs making livestock a net contributor to farm income but despite this the farmer says they may struggle without BPS payments.

9.5. Case Study 3

Formerly, this was a mid-size (~400 ha) intensive, but organic, mixed livestock hill farm in the Lake District. It was stocked with 60 continental cows, which were inside for seven months, crossbred sheep and used a model which relied on the use of farmyard manure on silage fields and purchased concentrate feed. In 2001, the farm size increased through the acquisition of National Trust and Forestry Commission tenancies. These tenancies came with caveats which meant taking a more extensive approach. Sheep production reduced and there was a shift from continental cattle to traditional cattle breeds which remain outdoors all year round. The farm entered a programme which meant further extensification, planting more trees and entering land into biodiversity and natural regeneration. No fertiliser is currently used, and former silage fields have been transformed into hay meadows. Increased AES and woodland creation payments, large reductions in input costs and off-farm income means this farm will remain viable after removal of BPS payments.

Table ST3. The percentage and direction of change, of greenhouse gas emissions and carbon sequestration for three case study farms before and after farming practice change.

	CSF 1		% ±	CSF 2		% ±	CSF 3		% ±
Year	2013	2019		2012	2019		2009	2019	
CARBON DIOXIDE (kg CO_2e)									
Direct CO_2									
Whole farm	13,168	8,785	-33%	11,795	11,156	-5%	21,936	20,583	-6%
Beef	3,660	0	-100%	3,457	6,486	88%	11,649	9,288	-20%
Sheep	9,508	8,785	-8%	8,338	4,670	-44%	10,287	11,295	10%
Indirect CO_2									
Whole farm	23,751	1,627	-93%	39,603	2,614	-93%	25,174	12,104	-52%
Beef	5,601	0	-100%	310	528	70%	21,971	10,870	-51%
Sheep	18,151	1,627	-91%	39,293	2,011	-95%	3,203	1,234	-61%
Total CO_2 from energy and waste									
Whole farm	36,919	10,412	-72%	51,398	13,770	-73%	47,110	32,687	-31%
Beef	9,261	0	-100%	3,767	7,014	86%	33,621	20,158	-40%
Sheep	27,659	10,412	-62%	47,631	6,756	-86%	13,490	12,529	-7%
METHANE									
Total CO_2e from methane (kg CO_2e)									
Whole farm	100,274	8,510	-92%	299,659	390,299	30%	317,624	480,699	51%
Beef	14,833	0	-100%	161,988	333,332	106%	159,931	250,664	57%

Sheep	85,441	8,510	-90%	137,670	56,968	-59%	157,693	230,035	46%
NITROUS OXIDE									
Total CO_2e from nitrous oxide (kg CO_2e)									
Whole farm	35,979	2,709	-92%	104,687	145,090	39%	104,556	161,777	55%
Beef	6,351	0	-100%	64,274	127,124	98%	48,289	88,114	82%
Sheep	29,628	2,709	-91%	40,413	17,967	-56%	56,267	73,663	31%
Total CO_2e emissions from farming (kg CO_2e)									
Whole farm	173,172	21,631	-88%	455,744	549,159	20%	469,291	675,163	44%
Beef	30,445	0	-100%	230,029	467,469	103%	241,840	358,937	48%
Sheep	142,727	21,631	-85%	225,714	81,690	-64%	227,450	316,227	39%
Sequestration by forestry (kg CO_2e)	75,359	267,458	255%	87,120	87,120	0%	304,920	4,791,600	1471%
Net emissions from land use (kg CO_2e)	97,813	-245,827	-351%	368,624	462,039	25%	164,371	-4,116,437	-2604%
Whole farm CO_2e emissions per kg of farm output (kg CO_2e/kg)	23.50	66.76	184%	22.11	63.68	188%	16.48	45.85	178%
Product CO_2e emissions									
Beef									
Total kgCO_2e	30,445	0	-100%	230,029	467,469	103%	241,840	358,937	48%
(kgCO_2e/kg lwt)	6.62	0	-100%	20.18	35.55	76%	5.72	32.16	462%
Emissions per LU equivalent (kgCO_2e/LU)	7,892	0	-100%	4,517	4,667	3%	4,749	4,760	0%
Sheep									

Meat									
Total $kgCO_2e$	141,945	21,631	-85%	221,473	77,843	-65%	217,294	302,270	39%
($kgCO_2e$/kg lwt)	13.14	30.04	129%	7.24	24.08	233%	17.93	16.98	-5%
Wool									
Total $kgCO_2e$	782	0	-100%	4,241	3,848	-9%	10,156	13,957	37%
($kgCO_2e$/kg wool)	11.17	0	-100%	5.30	19.24	263%	16.93	17.45	3%
Emissions per LU equivalent ($kgCO_2e$/LU)	3,250	6,042	86%	4,967	4,851	-2%	4,560	4,266	-6%
Emissions per hectare ($kgCO_2e$/ha)									
Whole farm	2,742	560	-80%	2,650	3,193	20%	1,999	1,443	-28%
Beef	2,020	0	-100%	756	1,310	73%	1,846	456	-75%
Sheep	970	214	-78%	1,640	959	-42%	476	356	-25%
Farm and enterprise output (kg)									
Whole farm	7,368	324	-96%	20,610	8,624	-58%	28,473	14,726	-48%
Beef	2,438	0	-100%	6,042	6,970	15%	22,419	5,915	-74%
Sheep	4,930	324	-93%	14,568	1,654	-89%	6,054	8,811	46%

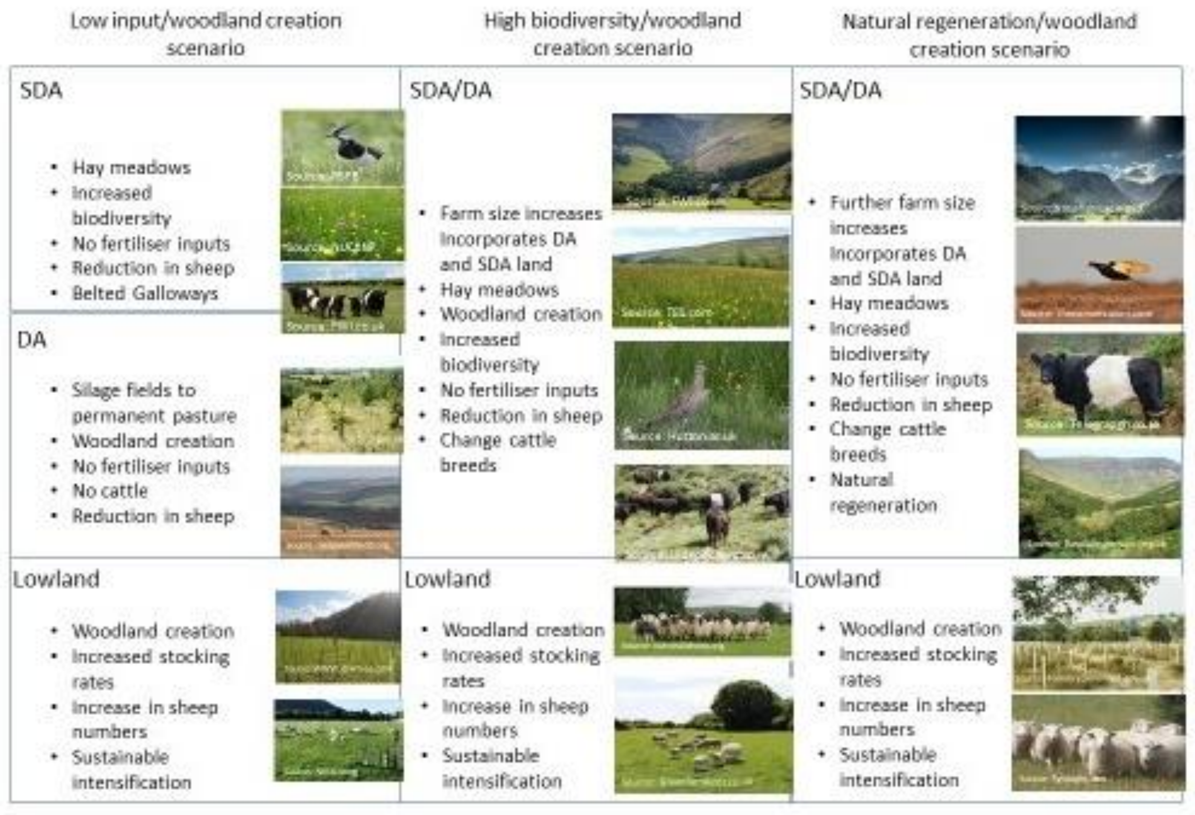

Figure SF15. The main changes to farm structure and land use that form the basis for land use change scenarios used to estimate GHG emissions from farm profiles in Seriously Disadvantaged (SDA), Disadvantaged (DA) and Lowland grazing sectors.

9.6. Farm structure, farm profiles and scenario emissions

The attached excel file shows the farm structure for the baseline sector profiles and shows the revised structure under scenarios 1, 2 and 3. The baseline farm profile sheet shows the baseline farm profile for the lowland grazing sector following the removal and redistribution of at-risk farms. The farm profile DF scenario 1 gives an example of how farm profiles were changed for input into AgRECalc. The file then shows how individual farm typology emissions were combined to create scenario emission totals and percentage change for a baseline.

Microsoft Excel
97-2003 Worksheet