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Public Goods and Externalities: Agri-environmental Policy Measures in the United Kingdom

James Jones,

Paul Silcock,

Tetsuya Uetake

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Abstract

**PUBLIC GOODS AND EXTERNALITIES:
AGRI-ENVIRONMENTAL POLICY MEASURES IN THE UNITED KINGDOM**

James Jones, Cumulus Consultants Ltd.,
Paul Silcock, Cumulus Consultants Ltd.,
and
Tetsuya Uetake, OECD

Agriculture is a provider of commodities such as food, feed, fibre and fuel and, it can also bring both positive and negative impacts on the environment such as biodiversity, water and soil quality. These environmental externalities from agricultural activities may also have characteristics of non-rivalry and non-excludability. When they have these characteristics, they can be defined as agri-environmental public goods. Agri-environmental public goods need not necessarily be desirable; that is, they may cause harm and can be defined as agri-environmental public bads.

Public Goods and Externalities: Agri-environmental Policy Measures in the United Kingdom aims to improve our understanding of the best policy measures to provide agri-environmental public goods and reduce agri-environmental public bads, by looking at the experiences of the United Kingdom. This report provides information to contribute to policy design addressing the provision of agri-environmental public goods including the reduction of agri-environmental public bads. It is one of the five country case studies (Australia, Japan, Netherlands, United Kingdom, and United States), which provide inputs into the main OECD book, *Public Goods, Externalities and Agri-environmental Policy Measures in Selected OECD Countries*.

***Keywords*:** public goods, externalities, agri-environmental policies, United Kingdom

***JEL classification*:** Q52, Q53, Q54, Q56, Q57, Q58

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Executive summary

Policy measures for providing agri-environmental public goods in the United Kingdom are reviewed in this study. It is one of the first studies to try to synthesise a broad range of agri-environmental policies and agri-environmental public goods in the United Kingdom.

Agri-environmental policies target nine agri-environmental public goods in the United Kingdom i.e. agricultural landscapes, biodiversity, water quality, water quantity, soil quality, climate change – carbon storage, climate change – greenhouse gas emissions, air quality, resilience to natural disaster (flooding and fire). Agri-environmental public goods can be defined as environmental externalities from agricultural activities which have characteristics of non-rivalry and non-excludability.

Most agri-environmental public goods are jointly produced with agricultural and food production activities in the United Kingdom. The greatest range and quantity of agri-environmental public goods is associated with extensive grazing livestock farms and extensive mixed farms in both lowland and upland areas. Arable cropping and intensive grazing livestock farms deliver more limited, but nonetheless important agri-environment public goods. Environmental costs are particularly associated with intensive cropping and livestock systems. The provision of agri-environmental public goods has been enhanced through increasing coverage and changes to agri-environment schemes; these target the drivers influencing the provision of agri-environmental public goods, rather than the public goods themselves.

There is strong demand and a continuing need for agri-environmental public goods, but a mixed picture in terms of supply in the United Kingdom. Demand is based on proxy indicators, Willingness to Pay studies and the country's environmental accounts for agriculture. Supply of some agri-environmental public goods is increasing, with others decreasing and a number unclear. The lack of markets for agri-environmental public goods is the key factor influencing supply, although this is addressed, to a significant extent, by publicly-funded schemes and programmes.

A balance of regulation, voluntary agri-environment schemes and technical assistance is used to achieve agri-environment priorities in the United Kingdom. Much regulation is drawn together and given added force by being included in cross compliance. While there is a broadly similar approach across the UK, there are differences in the detail of design and implementation at country level due to the devolved regional structure of government. The reform of the CAP will mean that the nature and balance of programmes will be altered for the period 2014-2020.

A wider range of agri-environment policy measures to address environmental issues could be beneficial. Negative incentives (taxes or charges), policy measures targeting environmental outcomes and the co-ordination of different policy measures could all be explored.

The costs associated with the provision of agri-environmental public goods should be kept under review. Not all agri-environmental public goods have clear reference levels and environmental targets, and even where they do, these are not presented and communicated clearly and coherently. While cross compliance conditions comprise the reference levels for most goods, the reference levels for the others are based on current farming practices implying that the government may need to make payments to achieve sustainable farming practices. There could be value in discussing and reviewing to what extent farmers should bear the costs and to what extent governments/ society should bear the costs.

Interesting approaches are being undertaken by private companies in the form of Payment for Ecosystem Services schemes. The achievements of these schemes need to be monitored, and their wider potential assessed, in order to improve the cost-effectiveness of agri-environmental policies.

1. Introduction

The United Kingdom has a relatively high population density, and pressure on land and the products and services from land is increasing. Agriculture is the predominant land use in the United Kingdom, accounting for 70% of total land area in 2012 (DEFRA et al., 2012), with other key land uses including forestry and urban/developed land. The United Kingdom has the highest percentage of land in agriculture of any OECD country (OECD, 2013a). Farming systems and enterprises vary across the country, with arable cropping predominating in the South and East of the country, and livestock enterprises in the North and West. Arable land accounts for 36% of Utilisable Agricultural Area (UAA), permanent grassland 57% and other land, including farm woodland, 7% (DEFRA et al., 2012).

While agriculture accounts for a relatively small proportion of the United Kingdom's economy and employment, the sector is important in terms of land area, food production and the delivery of a range of agri-environmental public goods such as agricultural landscapes, biodiversity, carbon storage and flood prevention. The delivery of these agri-environmental public goods is a common aim in each of the four Rural Development Programmes (RDPs) in the United Kingdom; one for each of the four home countries – England, Wales, Scotland and Northern Ireland. The responsibility for developing and implementing agri-environmental policies in each country rests with the relevant devolved governments. There is a considerable body of research relating to agri-environmental policies in the United Kingdom, although this mainly relates to publicly funded programmes as opposed to regulations, technical advice and private sector mechanisms. There are few studies which cover a broad range of different agri-environmental policy measures including public funded programmes, regulations technical advice and private sector mechanisms and provide a holistic view of the complicated multi-layered policy measures for agri-environmental public goods in the United Kingdom.

The purpose of this paper is to review United Kingdom agri-environmental policies and explore the following points:

- What kind of agri-environmental public goods are targeted in the United Kingdom?
- How are these agri-environmental public goods provided for in United Kingdom agricultural systems?

- Is there under- or over-provision of agri-environmental public goods, i.e. does market failure associated with agri-environmental public goods exist?
- Where market failure exists, who should bear the costs for providing agri-environmental public goods? To what extent should farmers bear the costs for providing these agri-environmental public goods, and to what extent should society? How does the United Kingdom set agri-environmental targets and reference levels?
- What policy measures are implemented for agri-environmental public goods in the United Kingdom and which policy measures target which agri-environmental public goods?

The paper is organised as follows: Section 2 summarises the main agri-environmental public goods targeted in the United Kingdom; Section 3 discusses the provision mechanisms of these public goods; Section 4 examines market failure of these goods; Section 5 provides a reference level framework in the United Kingdom to identify to what extent the costs should be borne by farmers or society; Section 6 shows how United Kingdom agri-environmental policies are organised; and Section 7 concludes the discussion.

2. Agri-environmental public goods targeted in the United Kingdom

United Kingdom agricultural and agri-environmental policy is influenced by European Union (EU) and national/country level factors. At EU level, the policy framework for agri-environmental public goods is provided by the Common Agricultural Policy (CAP), in particular the rural development pillar (Pillar 2). The current rural development regulation is *Commission Regulation (EC) No 1698/2005* although this is likely to be revised in the near future in line with recent political agreement on CAP 2014-2020. EU policy is applied and implemented at United Kingdom level through individual country RDPs, currently operating over the period 2007-2014. By reviewing the main agri-environmental policies in the United Kingdom, and examining the environmental objectives targeted by them, this study identifies that nine agri-environmental public goods are targeted in the United Kingdom (Table 1).[1] Agri-environmental public goods can be defined as environmental externalities from agricultural activities which have characteristics of non-rivalry and non-excludability.

Table 1. Main agri-environmental public goods targeted in the United Kingdom

Agricultural landscapes	Climate change – carbon storage
Biodiversity	Climate change – greenhouse gas emissions
Water quality	Air quality
Water quantity/availability	Resilience to natural disaster
Soil quality and protection	

The landscape of the United Kingdom is predominantly an **agricultural landscape**, the product of many thousands of years of human activity and management through

1. Although social public goods (e.g. rural vitality, food security) are important policy targets in the United Kingdom, this study focuses on agri-environmental public goods. This is because the purpose of this study is to contribute to the development of better agri-environmental policies, and dealing with social public goods would include a broader discussion beyond the field of agri-environmental policies.

farming. The United Kingdom has a rich and varied landscape, linked to differing physical conditions and farming systems. Associated with these is a wide range of habitats and species, **biodiversity.** Examples of this variety include intensive arable landscapes, lowland pastoral areas (with improved, semi-improved and unimproved grasslands), coastal landscapes (including wet grassland, managed reedbeds and grazed saltmarsh) and significant areas of upland (including upland heathland, grasslands and blanket bog) which provide a range of ecosystem services, see Box 1. Landscapes and biodiversity are protected through planning law and designations, as well as agri-environment schemes.

Agriculture in the United Kingdom influences **water quality** positively and negatively. The extensive management of upland areas contributes to the maintenance and improvement of water quality, which is important given that 70% of the nation's water supply is sourced from upland areas (JNCC, 2003). However poor management can result in problems in terms of siltation, pathogens and discolouration. In areas used for cropping and intensive livestock enterprises (e.g. dairying and some beef production), excessive fertiliser, manure and pesticide applications can also adversely affect the quality of water, in terms of nitrate and phosphate pollution leading to eutrophication. The impacts are dependent not only the land use and management, but also on soil types, pathways and the nature and sensitivity of the water bodies. Water pollution from agriculture, both point and diffuse source, is a particular concern and priority in the United Kingdom, particularly with the implementation of the EC Water Framework Directive which requires water bodies to be in good ecological quality by 2015. The total annual cost of water pollution to river and wetland ecosystems and natural habitats in England and Wales is estimated to lie between GBR 716 and GBR 1 297 million; with agriculture comprising a major contributor to this (DEFRA, 2008).

Box 1. Less Favoured Areas in the United Kingdom

The "Less Favoured Areas" (LFA) in the United Kingdom comprise the majority of the uplands of England, Wales, Scotland and Northern Ireland, together with other areas of low or limited agricultural potential. Defined in accordance with EU Directive 75/2767, LFAs comprise 53% of UAA or 9.12 million hectares; this varies by country, with LFA comprising 17% of UAA in England, 70% in Northern Ireland, 80% in Wales and 86% in Scotland (Cumulus Consultants, 2012). The LFAs are predominantly farmed extensively, through grazing with cattle, sheep and to a lesser extent, ponies, and forage production in the form of hay and silage on lower lying land ("in bye").

The LFAs hold significant continuous tracts of the United Kingdom's remaining areas of semi-natural upland habitats (e.g. heather moorland, blanket bog and upland grassland) as well as less productive, lowland habitats (e.g. lowland bog, fen, floodplain grazing marsh and hay meadow), especially in Northern Ireland. Many sites within the LFA are afforded national or European protected status for their biodiversity interest. Many upland areas within the LFA are also designated as National Parks or Areas of Outstanding Natural Beauty highlighting their importance for the preservation of undeveloped, scenic landscapes as well as recreation and tourism. LFAs provide a range of ecosystem services including: food and fibre production; water supply (quantity and quality of drinking water); flood risk reduction; use and enjoyment for outdoor recreation and field sports; historic and cultural landscape management; renewable energy provision; the regulation of greenhouse gas emissions; and biodiversity (Natural England, 2009).

LFA farms make a significant contribution to the United Kingdom's agri-environmental public goods, however they are also often economically vulnerable, with relatively low profitability and a high dependency on public support payments. For example, Farm Business Income (FBI) for LFA grazing livestock farms in England averaged GBP 29 213 in 2011/12, with the Single Payment Scheme, agri-environment and other payments amounting to 94% of FBI (RBR, 2012). Public support payments for LFA farming vary across the UK, and are dependent amongst other things on the policies and schemes of the devolved authorities. These payments are under review presently with the reform of the CAP 2014-2020.

Agriculture generally has a limited impact on **water quantity** in the United Kingdom, given the country's relatively high rainfall and low agricultural demand. There are exceptions however, with arable farming competing for increasingly scarce water resources in the drier areas of the South East and East of England. Potatoes, sugar beet and vegetables, in particular, are dependent on irrigation in these areas. Lower rainfall in recent years, together with increasing demand from a range of users, is requiring farmers to be more efficient in the use of water, and encouraging investment in rainwater harvesting and reservoirs to collect and store water during the winter months for use during the summer.

Agriculture impacts on **soil quality**, since most agriculture is dependent on the soil for its production. Soil quality is a particular issue for arable, mixed and intensive grassland farming in the United Kingdom. Well managed farms, with good cultivation and crop rotation practices, can enhance soil quality in terms of improved soil structure and organic matter. On the other hand, inappropriate cropping, cultivations and input use and other poor management can lead to problems in terms of soil erosion, compaction and even contamination; with the impacts dependent on factors including soil type, slope and rainfall. There is increasing attention on improving soil management in the United Kingdom, not only for its own sake and its productive value, but also for its contribution to biodiversity, water quality and reducing greenhouse gas emissions (EA, 2004).

Agriculture impacts on both air quality and climate change, and therefore maintaining good **air quality** and **stabilising the climate** are also public goods in the United Kingdom. Air quality can be adversely affected by odours and ammonia emissions from livestock housing and the storage and spreading of manure and slurry. It can also be negatively impacted by the burning of crop residues, waste materials and, in upland areas, grass and heather. Minimising contamination from these various sources can be achieved through the adoption of specific farming management practices (Cooper et al., 2009). Although agriculture is a net contributor of greenhouse gas emissions, a wide range of agricultural practices can reduce **greenhouse gas emissions** and promote **carbon storage**. Reducing greenhouse gas emissions and enhancing carbon storage is a key focus of farm advice and supported more generally through agri-environment and farm assurance schemes.

The other main agri-environmental public good in United Kingdom is **resilience to natural disasters** such as flooding and fire. Agriculture has an important role in flood prevention. In upland areas, good grazing management can contribute to improved soil permeability, water storage and a reduction in the speed of run-off. In lowland areas, run-off can be reduced through good land use, cropping and management practices. With more frequent, extreme rainfall events in recent years, the role of agriculture in reducing flood risk to people and property is becoming increasingly important and is a cost effective alternative to engineered flood defences (POST, 2011; Jones, M.,2010). Grazing management and controlled burns in the uplands can make an important contribution to reducing the risk of wildfires, with associated benefits for biodiversity and water quality.

3. Provision mechanisms of agri-environmental public goods

Most agri-environmental public goods are jointly produced in conjunction with agricultural and food production activities in the United Kingdom. Extensive grazing livestock farms – especially those involved with beef and sheep production – and extensive mixed grazing/arable farms deliver a great range of high quality agri-environmental public goods (Cooper et al., 2009). Extensive grazing livestock and mixed

farms in both lowland and upland areas are closely associated with "High Nature Value farming"; a concept developed in the 1990s to describe low intensity farming which favours the dynamics of natural processes and create opportunities for biodiversity to flourish (Opperman et al., 2012), see Box 2. In addition to biodiversity, these farming systems deliver other agri-environmental public goods including agricultural landscapes, water quality, flood risk reduction and carbon storage. Other types of farm, including arable cropping and intensive grazing livestock farms, deliver more limited but nonetheless important agri-environmental public goods such as agricultural landscapes and biodiversity. The contribution of agriculture to the delivery of agri-environmental public goods, especially biodiversity and landscapes has grown with increasing coverage and changes to agri-environmental schemes (OECD, 2008b).

Agricultural and food production in the United Kingdom is also associated with a range of environmental costs. These are particularly associated with intensive farming systems, including intensive cereal cropping, general cropping, dairying and pig and poultry production. The environmental costs include the loss of nutrients which can adversely impact water quality (nitrogen and phosphorus in rivers), the emission of greenhouse gases and other gases (nitrous oxide, methane and ammonia), the abstraction of scare water supplies for irrigation, and, albeit less commonly now, the loss of habitats which negatively affects wildlife (DEFRA et al., 2013; OECD, 2013a). Agricultural pressure on the environment has eased with the reduction in input usage and uptake of agri-environment schemes, although issues remain linked to the intensity of farming systems in certain areas, and the extent of diffuse agricultural production. The management and conservation of soils, water, biodiversity and landscapes remain priority environmental issues (OECD, 2008b).

Box 2. High Nature Value Farming in the United Kingdom

High Nature Value (HNV) farmland in the United Kingdom predominantly consists of semi-natural pasture under low-intensity livestock raising systems (suckler cow and sheep) operating at a landscape scale.

HNV farmland areas in the United Kingdom are described below:

- The main areas are the uplands of the North and West, where semi-natural farmland dominates at landscape scale.
- In lowland areas, semi-natural farmland is rarer at landscape scale and is normally only present at field scale. Often semi-natural grassland occurs in a mix with semi-improved grassland, often in smaller field patterns. In these areas, field boundaries (hedges, dry stone walls, earth banks) are significant habitats in their own right.
- In other areas, HNV farmland is present only occasionally and locally.

A considerable proportion of HNV farmland occurs in the Less Favoured Areas (see Box 1) however it also occurs outside these areas. Low-intensity arable cropping survives in a few very specific locations as part of a HNV mosaic, for example with the machair grasslands in the Western Isles of Scotland.

HNV farming systems, which are typically characterised by low profitability, are supported, to an extent, by agri-environment and other public payments.

Sources: European Forum for Nature Conservation www.efncp.org/projects/united-kingdom/; Opperman, R., Beaufoy, G. and Jones, G. (2012), *High Nature Value Farming in Europe: 35 European countries – experiences and perspectives*, Verlag Regionalkultur, Ubstadt-Weiher.

Some agri-environmental public goods are delivered through historic or cultural infrastructure and management practices, which may no longer be directly linked to mainstream agriculture. Examples include boundary features such as hedges, walls, banks and ditches which contribute to agricultural landscapes and biodiversity.

Figure 1 is a simple framework of provision mechanises of agri-environmental public goods in the United Kingdom. In addition to agricultural infrastructure, farming systems, farming practices and farm inputs also affect the state of the environment. Thus, to provide an adequate amount of agri-environmental public goods, an analysis of the factors which directly and indirectly affect the status of agri-environmental public goods is necessary. Broadly speaking, policy measures target drivers (*in-put based* or means) and agri-environmental public goods (*out-put based* or ends) (OECD, 2010a). But, before developing and discussing policies, it is necessary to examine whether agri-environmental public goods are underprovided/overprovided in the United Kingdom and whether governments need to intervene to deal with market failures.

Figure 1. Provision mechanisms of agri-environmental public goods in the United Kingdom

Drives	**Agri-environmental public goods**
Agricultural infrastructure e.g.: • Farmland – area and land use • Farmland features – hedges, walls, banks, ditches Farming systems e.g. • Extensive grazing livestock • Extensive mixed arable/ pastoral • Organic farming Farming practices e.g. • Retention of field boundaries • Use of green manure/cover crops • Shepherding to avoid over/ undergrazing Farm input use e.g. • Nutrients • Pesticides • Water Energy	• Agricultural landscapes • Biodiversity • Water quality • Water quantity/ availability • Soil quality and protection • Climate change – carbon storage • Climate change – greenhouse gas emissions • Air quality • Resilience to natural disaster

4. Market failure for agri-environmental public goods

Markets for agri-environmental public goods are, generally speaking, under-developed, which makes it difficult for farmers to produce an adequate amount of agri-environmental public goods without the support of government (OECD, 1992, 1999, 2013b; Ribaudo et al., 2008). In the UK, publicly-funded agri-environment schemes have been in operation for 25 years and now cover a significant proportion of farmland (around 70% of Utilisable Agricultural Area in England). Without government intervention, agri-environmental public goods would be underprovided by the market as they are subject to

non-rivalry and non-excludability.[2] To justify government intervention, evidence of market failure is necessary in each case and the benefits need to outweigh the additional costs. This market failure, in the form of externalities and the provision of public goods, is recognised in the recent impact assessment of the RDP for England 2014-2020, and forms part of the rationale for the future funding of agri-environment and forestry schemes (Defra, 2013g).

It is difficult to estimate the scale of demand and supply of agri-environmental public goods because of the absence of markets. In reality, instead of data which directly estimate the amount of agri-environmental public goods, some proxies are often used in practice. This section provides some recent efforts for addressing this issue in the United Kingdom.

4.1. Demand for agri-environmental public goods

Proxy indicators

The main approach for estimating the demand for agri-environmental public goods is to look at representative indicators or expressions of behaviour (using proxy indicators).

Demand for **agricultural landscapes** and **biodiversity** is reflected in support for voluntary associations active in landscape and biodiversity. This support has a long history in the United Kingdom stemming from an amateur naturalist tradition, and the high value placed on rights of access to the countryside. The strength and breadth of this support is outlined in Box 3.

Further evidence of public concern and interest in agri-environmental public goods including agricultural landscapes and biodiversity is provided in a recent report produced on behalf of the Oxford Farming Conference (Carruthers et al., 2013). This highlights, in addition to the points made above: the celebration of landscapes in art, literature and music; and the number and extent of landscape and biodiversity designations, many of which are located on farmland. The same report cites a 2009 IGD[3] survey of consumers. This found that a significant proportion of consumers felt that managing the countryside (agricultural landscapes) was an important contribution made by farmers to British society (33%, first or second choice) with a smaller proportion opting for encouraging wildlife (biodiversity) in the countryside (13%).

Demand for **climate change, air quality** and **water quality** in particular is evident from United Kingdom respondents to the Eurobarometer State of the Environment Survey which surveyed the attitudes of respondents from all EU countries (DG Communication, 2009).[4] The survey showed that climate change, air quality and water quality are of most concern to respondents, followed by agricultural landscapes, biodiversity and agricultural pollution, see Table 2.

2. In an economic sense, public goods are goods that are non-rival and non-excludable. A good is non-rival if the consumption by one person does not diminish the ability of others to consume it. A good is non-excludable if a person cannot be excluded from consuming that good. Public goods that exhibit both characteristics (e.g. a pleasant rural landscape) are pure public goods.

3. IGD stands for the Institute of Grocery Distribution. IGD is a food and consumer goods charity, see www.igd.com/.

4. This was based on interviews. In the UK, there were 1 314 interviews. In the EU27, there were 27 218 interviews.

Box 3. Evidence of widespread demand for landscapes and biodiversity in the United Kingdom

The nature conservation movement in the UK is over one hundred years old and has a combined membership of over 6 million in 2011/12 (just under 10% of the UK population), up from 5 million in 2006/7.

The National Trust "for places of historic interest or natural beauty" is the world's largest conservation society, with 3.9 million members, 67 000 volunteers and over 250 000 hectares of land across England, Wales and Northern Ireland (2011/12). The National Trust for Scotland has 312 000 members (2011/12).

The Royal Society for the Protection of Birds (RSPB) has a membership in excess of 1 million members and owns almost 130 000 hectares on 200 reserves across the UK (2013).

The UK Wildlife Trusts have a membership of 800 000, and welcome over 7 million visitors to its 2 300 reserves covering 93 000 hectares (2011/12).

Ramblers Association has over 110 000 members (2010/11), with their members and society at large enjoying access to thousands of kilometres of public pathways.

National Parks also provide an indication of the scale of public demand for landscapes – many of which are agricultural. National Parks in England alone attracted 95 million visitors (2011) with annual visitor expenditure in the Parks and areas of influence amounting to around GBP 4 billion (2011). The number of visits to Areas of Outstanding Natural Beauty is also high. Adult visitors made 1.42 billion visits to the countryside in England in 2011/12.

Sources: www.nationaltrust.org.uk/what-we-do/; www.rspb.org.uk/about/facts.aspx; www.wildlifetrusts.org/annualreview; www.nationalparksengland.org.uk/home/about-national-parks-england; http://publications.naturalengland.org.uk/file/1755933.

Table 2. Evidence of concern for environmental issues (demand for agri-environmental public goods) (Eurobarometer State of the Environment Survey, 2009 – United Kingdom respondents)

Agri-environmental public goods	Category of the Environment Survey	Percentage of United Kingdom respondents to the Environment Survey[1] concerned about particular environment issues
Climate change – carbon storage	Climate change	53%
Climate change – greenhouse gas emissions		
Air quality	Air pollution	42%
Water quality	Water pollution	35%
Agricultural landscapes	Depletion of natural resources	27%
Biodiversity	Loss of biodiversity	20%
Water quantity/availability	NA	NA
Soil quality and protection	NA	NA
Resilience to natural disaster	NA	NA

1. 18% of respondents were concern about agricultural pollution in general.
Source: DG Communication (2009), *The Europeans in 2009, Special Eurobarometer*, 308/Wave 71.1, European Commission: Brussels.

More general demand for agri-environmental public goods is evident from the large proportion of United Kingdom respondents to Eurobarometer State of the Environment Survey who indicated that protecting the environment is very important to them personally (65%). In considering future policy and legislation, a large proportion of United Kingdom respondents (70%) also felt that European legislation was necessary for protecting the environment in the country (70%) and more money should be allocated by the EU to the protection of the environment even if this means that less money is spent on other areas (71%). The survey also showed that a significant proportion of United Kingdom respondents had, for environmental reasons, chosen locally produced products or groceries (30%) and bought environmentally friendly products marked with an

environmental label (23%); this broadly correlates to the results of the IGD survey referred to previously. A high proportion of United Kingdom respondents (70%) felt they were (very or fairly) well informed about environmental issues. Attitudinal surveys of this kind point to widespread concern amongst the European public for environmental issues, as well as the high value that is placed on the environment, which is backed up in the academic literature (Cooper et al., 2009).

There are no proxy indicators, which we are aware of, specifically relating to the demand for **water quantity, soil quality,** and **resilience to natural disaster** (flooding and fire) at a national level.

Within the wide range of agri-environment data collected and recorded by government in the United Kingdom, there is only limited data which may be regarded as indicative of demand for agri-environment public goods. To an extent, the number and area of agri-environment scheme agreements in the United Kingdom is a reflection of the Government's demand (and the budget available) for agri-environmental public goods. The number of these agreements has more than doubled, from 36 300 to 86 000, over the period 2000-2012 (DEFRA et al., 2012).[5] However this data also reflects farmers' willingness to accept agri-environment scheme payments and supply such goods.

More and better data could be gathered to show demand for different agri-environmental public goods, however the available evidence suggests strong demand from the public and farmers for agri-environmental public goods in the United Kingdom. Existing demand-related data is used to influence policy and programmes, in broad terms, and complemented by feedback from public consultations (relating to specific legislation and programmes). However, the EU (and, indirectly, lobbying and consultation at EU-level) remains a key driver in terms of agri-environmental policy and legislation in the United Kingdom.

Monetary valuation

The other approach for estimating the demand for agri-environmental public goods is to apply monetary valuation methodologies to reveal social preference about agri-environmental public goods. There are a number of studies which have explored the value of agri-environmental public goods in the United Kingdom; with most focusing on **agricultural landscapes**, **biodiversity** (habitats), **water quality and quantity**. These studies typically report public good values in terms of annual household willingness to pay (WTP). McVittie et al. (2008) produced figures for average WTP per household based on a review of valuation studies (Table 3).

5. Agri-environment scheme agreement holders are monitored by Defra for England (https://www.gov.uk/government/statistical-data-sets/agri-environment-indicators) and at UK level, reported through "Agriculture in the United Kingdom". Agri-environment schemes referred to include those in organic farming schemes. Figures adjusted to avoid ELS/HLS overlap in England and checked with Elizabeth Finch, Defra 18/2/2014.

Table 3. Willingness to Pay for agri-environmental public goods

Agri-environmental public goods	WTP
Agricultural landscapes (including different habitats and features)	Average WTP per household ranged from GBP 11.49 for rough grazing through to GBP 79 for chalk grassland, and GBP 27.49 for general landscape appearance. Average unit values included: GBP 23/km for hedgerows and arable headlands; GBP 25/ha for heather moorland; GBP 90/ha for chalk grassland; and GBP 99/ha for wetland.
Biodiversity	Average WTP per household was GBP 50.94. Other average WTP values (not per household) include GBP 773/ha for Sites of Special Scientific Interest in favourable condition and GBP 5 515 461/unit change in the Farmland Bird Index
Water quality	Average WTP per household included GBP 55.27 for non-specified improvement in water quality
Water quantity/availability	Average WTP per household included GBP 6.72 for an improvement in water quantity
Climate change – greenhouse gas emissions	NA
Climate change – carbon storage	NA
Air quality	NA
Soil quality and protection	NA
Resilience to natural disaster	NA

Source: McVittie, A, D. Moran and S. Thomson (2008), *Value of Public Goods from Agriculture and the Production Impacts of the Single Farm A Review of Literature on the Value of Public Goods from Agriculture and the Production Impacts of the Single Farm Payment Scheme*, SAC, Edinburgh.

It is important to note that these estimates have not been adjusted to account for the scope of the policy or good being valued or the year the valuation study took place. Furthermore it is known that these values change depending on adopted methodologies, questions and procedures (Diamond and Hausman, 1994, Cooper et al., 2009). Obtaining robust WTP results is challenging given the inherent difficulties involved in valuing non-market goods, especially with stated preference techniques. These difficulties include establishing a hypothetical market, the difference between statements and actions, and the lack of reliability in transferring results from one situation to another.

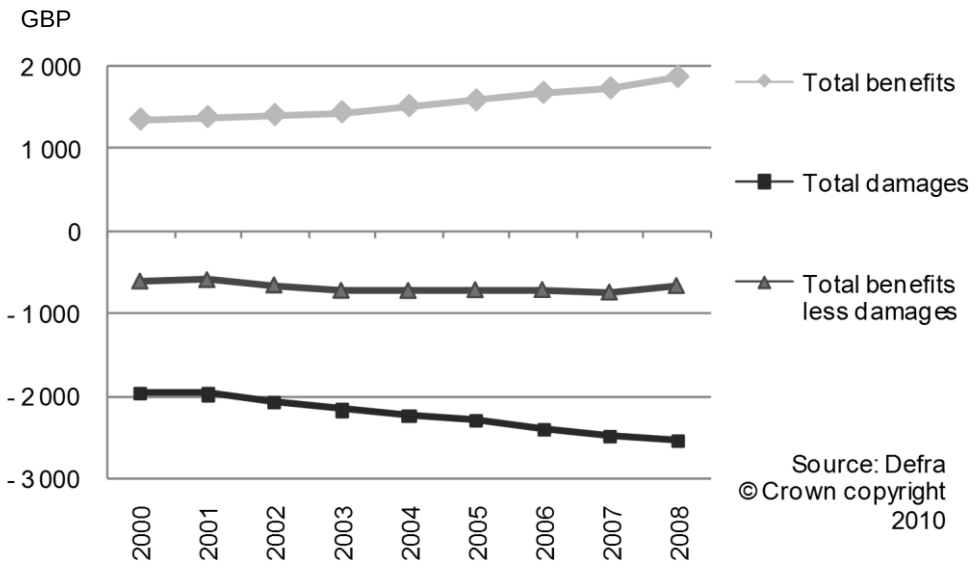
There are no aggregated United Kingdom WTP figures for agri-environment public goods. However, a series of studies relating to Environmentally Sensitive Area (ESA) schemes in the 1990s estimated average agri-environment scheme WTP values per household to be GBP 28.54 or GBP 89.89 (depending on valuation method) (McVittie, 2008). More recently WTP values have been estimated for Environmental Stewardship in England; this indicated an average WTP per household of GBP 26.09 per year for the uptake of Environmental Stewardship in 2013,[6] as a conservative estimate (FERA et al., 2010). These WTP values are of some interest to policy-makers and scheme designers, however agri-environment policies and payments are governed by the CAP and rural development regulations; this requires payment rates to be based on income foregone and

6. When it was projected that 60% of farms would have Entry Level Stewardship only agreements, 10% of farms would have Entry Level and Higher Level Stewardship, and 30% of farms would not be in Environmental Stewardship.

additional costs, adjusted to ensure suitable uptake by farmers, as opposed to the public's WTP.

Additional insight into demand, or rather need, can be obtained from the United Kingdom's environmental accounts for agriculture (Jacobs and SAC, 2008). These show the increasing value of benefits, but also the increasing value of damages, with the net result that total benefits less damages has changed from –GBP 613 million to –GBP 669 million over 2000-08, see Figure 2. The main benefits derive from biodiversity and landscape; the value of benefits has increased due to improved quantity and quality of both types of public good. The main damages relate to greenhouse gas emissions, air quality and water; the value of damages has increased due, in particular, to increased costs associated with flooding, drinking water clean-up, greenhouse gas emissions and air quality (despite, in the case of the latter two categories, physical emissions reducing).

Figure 2. Environmental accounts for agriculture in the United Kingdom



Source: Defra (2010), *Agricultural Change and Environment Observatory Programme*, Defra, London: graph based on data derived from Jacobs and SA (2008), *Environmental Accounts for Agriculture*, Defra. London.

More recently, the United Kingdom National Ecosystem Assessment (UKNEA, 2011a) has provided a comprehensive assessment of the UK's natural environment, including enclosed and semi-natural farmland, in terms of the benefits it provides to society and continuing economic prosperity. This covers the wide range of different ecosystem services provided by farming. The accompanying economic analysis (UKNEA, 2011b) highlighted the considerable value provided by a broad range of ecosystem service flows. These include, amongst others: the contribution of ecosystem services to the production of terrestrial foods; the direct and indirect use value of biodiversity in underpinning and delivering ecosystem services; carbon sequestration, storage and greenhouse gas flux; water quality and quantity; inland and coastal flood protection; landscape values and the amenity value of nature; and the amenity value of the climate. By way of example, WTP estimates of the non-use (existence) value of terrestrial biodiversity, much of which is dependent on farming, range from GBR 540 million to GBR 1 262 million per year. It is also noted that the costs associated

with changing agricultural land use to reduce nutrient loadings into rivers are substantially smaller than the benefits which consequent reductions in diffuse water pollution would bring. More recent work indicates that the incorporation of ecosystem services and their values within analyses can substantially change decisions and is highly relevant to policy-makers (Bateman et al., 2014).

4.2. Supply of agri-environmental public goods

The United Kingdom has a wide range of environmental data for agriculture which provides a good indication of the supply of most agri-environmental public goods. There are some gaps in data, however, for example in relation to resilience to natural disaster. The trends for the supply of agri-environmental public goods in the United Kingdom are set out in Table 4. Overall, there is a mixed picture, with some agri-environmental public goods increasing with others decreasing.

Total farmland in the United Kingdom has decreased by 6% between 1990 and 2012, and this has arguably reduced agriculture's capacity to provide various ecosystem services in the United Kingdom. However, the decrease in farmland area needs to be countered by positive changes in terms of reduced intensity of management, improved management practices and environmental land management, including uptake of agri-environment schemes by farmers. The area under agri-environment schemes, for example, has increased nearly four-fold over the period 2000-12 from 2.41 million hectares to 9.55 million hectares (56% of UK Utilisable Agricultural Area) (DEFRA et al., 2013).[5] While more land under agri-environment schemes cannot be equated with a significant increase in the supply of agri-environmental public goods due to deadweight (Hyder Consulting (UK) Ltd, 2010), there will be some increase, for example in terms of the protection and enhancement of valued **agricultural landscapes**. In England, this trend is supported by the Countryside Quality Counts study which provided evidence about the way the English countryside is changing and found that 64% of Joint Character Areas show patterns of change consistent with maintaining or enhancing landscape character over the period 1999-2003. The areas classified as neglected or diverging tend to be concentrated in central and southern England (DEFRA, 2012a).

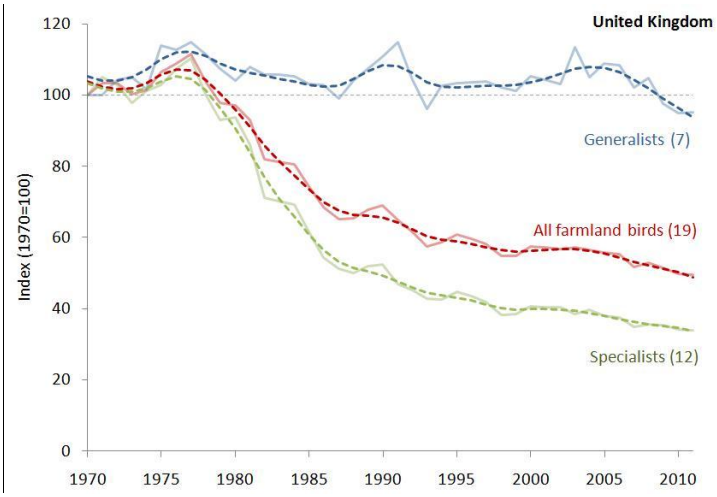
The key **biodiversity** indicator in the United Kingdom is the Farmland Bird Index, which comprises seven farmland generalist species and twelve farmland specialist species (those which are restricted to, or highly dependent, on farmland habitats). Bird populations are considered to be a good indicator of the general state of wildlife as they have a wide habitat distribution and are near the top of the food chain. The Farmland Bird Index showed a 50% reduction over the period 1970-2011, with particular declines in the populations of farmland specialist species, see Figure 3. Most of the decline in farmland bird populations occurred between the late 1970s and early 1990s largely due to the intensification and specialisation of farming, and related changes in farming practices, during this period (e.g. greater use of inorganic fertilisers and sprays, move from spring to autumn sowing, switch from hay to silage forage, and loss of mixed farming systems). While some agricultural practices still have negative impacts, the situation is complex with other pressures such as weather, disease and land development also contributing.

Table 4. Trends of agri-environmental public goods in the United Kingdom

	Trends	Related Indicators		Sources
Agricultural landscapes	+/-	• Farmland area • Agricultural landscape change	• -6% (1990-2012) • Positive change in 64% of National Character Areas in England over 1999-2004	• OECD (2013a)/ DEFRA et al (2013) • DEFRA (2012a) • UKNEA (2011)
Biodiversity	↘	• Farmland birds • Farmland butterflies	• -36% (1990-2011) and - 50% (1970-2011) • -25% (1970-2011)	• OECD(2013a)/ DEFRA et al (2013) • RSPB (2013a)
Water quality	↗	• Gross nitrogen balance • Gross phosphorus balance • Total sales of agricultural pesticides • Share of agriculture in total emissions of phosphorous in surface water	• -30% (1990-2009) • -54% (1990-2009) • -56% (1990-2010) • 29% (2000) to 19.5%(2009)	• OECD(2013a) • OECD(2013a) • OECD(2013a) • UKNEA (2011) • OECD(2013a)
Water quantity /availability	+/-	• Total agricultural water withdrawals • Agricultural share of total freshwater withdrawals	• -4% (from 1990/92 to 2006/8) • 12% (1990/2) to 15% (2006/8)	• OECD (2013a) • OECD (2013a) • UKNEA (2011)
Soil quality and protection	+/-	• Gross nitrogen balance • Gross phosphorus balance • Farmland at moderate or high risk of soil erosion • Soil organic matter	• -30% (1990-2009) • -54% (1990-2009) • 6% (1999) to 17% (2002) • -0.5% in England and Wales (1979/81-1995)	• OECD(2013a) • OECD(2013a) • OECD (2013a) • EA (2004) • UKNEA (2011)
Climate change – carbon storage	~	• Arable and horticultural soil carbon storage	• Slight decline in England over 1978-2007	• DEFRA (2013a)
Climate change – greenhouse gas emissions	↗	• Total GHG emissions from agriculture • Methane emissions from agriculture • Nitrous oxide emissions from agriculture • Direct on-farm energy consumption	• -20%(from 1990 to 2010) • -20% (from 1990 to 2010) • -20% (from 1990 to 2010) • -23% (from 1990 to 2010)	• OECD(2013a) • OECD(2013a) • OECD(2013a) • UKNEA (2011) • OECD(2013a)
Air quality	↗	• Total ammonia emissions from agriculture	• -24% (from 1990 to 2011)	• OECD(2013a) • /DEFRA et al 2013) • UKNEA (2011)
Resilience to natural disaster	~	• Farmland area	• -6% (1990-2012)	• OECD(2013a)/ • DEFRA et al (2013) • UK NEA (2011)

Note: ↘ (decreasing). ↗ (increasing). +/- (both increasing and decreasing data). ~ (no or insufficient data).

Figure 3. Breeding farmland bird populations 1970-2011 in the United Kingdom



Source: RSPB, BTO, JNCC, DEFRA, as shown in DEFRA (2012b), *National Statistics Release: Wild bird populations in the UK, 1970 to 2011*, Department for Environment, Food and Rural Affairs, London.

Butterfly numbers on farmland have also declined, by more than 25% over 1975-2010, although there have been wide fluctuations from year-to-year (RSPB, 2013a); this indicator is based on changes in the populations of 21 widespread butterfly species on less intensively managed areas within the farmed landscape. The populations of six widespread bat populations have increased, however, by 18% since 2000; this may be partly due to more effective conservation measures and milder winters (RSPB, 2013a).

More generally, data shows that the majority of species for which trends are available have declined on both enclosed farmland and in upland areas over the past 50 years. On enclosed farmland, 60% of species have declined mainly due to loss of habitat, changing farming practices, and increased chemical inputs designed to boost productivity. In upland areas, 65% of species have declined due to habitat loss, degradation and fragmentation and loss of diversity. Other species have stabilised or increased in number (RSPB, 2013).

In terms of agricultural habitats, there has been an overall loss of farmland to forestry and urban use, a reduction in semi-natural farmed habitats, a switch from cropped land to improved grassland, and an expansion of farm woodland (OECD, 2008b). Evidence from England for the 12 UK Biodiversity Action Plan priority habitats which are predominantly agricultural, two are increasing in extent, five are stable, four are declining and one is unknown (DEFRA, 2013b).

Improving **water quality** is a key challenge in the United Kingdom and one which has been attracting increasing focus due to the implementation of the EC Water Framework Directive. A high level of nitrogen and phosphorus in agricultural soils increases the risk of their transportation to water bodies through drainflow (rainfall) events, soil erosion and leaching, and can result in nutrient concentrations leading to eutrophication and poor water quality. Recent trends in farmland nitrogen and phosphorus have been positive in the United Kingdom. The nitrogen balance has declined by 30% over 1990-2009, principally due to a reduction in application rates on grassland (with application rates on cropped land remaining relatively constant since 1983). The

phosphorus balance has declined by 54% over 1990-2009 due to a reduction in application rates on both grassland and cropped land (OECD 2013a, DEFRA et al., 2013). Despite these trends, it is estimated that agriculture is still a major source of pollution accounting for around 60% of total discharges of nitrogen in surface water and coastal waters, and 20% of total discharges of phosphorus in surface water and 30% in coastal water (OECD, 2013a). The United Kingdom also has the second highest score amongst OECD countries measured, in terms of percentage of agricultural area exceeding recommended drinking water limits for nitrates and phosphorus in surface water (OECD, 2013a)

Water pollution from pesticides has decreased, with a 56% reduction in pesticide sales between 1990 and 2009 (OECD, 2013). The decrease in pesticide use over this period was most likely associated with changes in cropping patterns and weather conditions (OECD, 2008b) as well as a marginal reduction in production and an expansion in the number of farmers adopting environmentally beneficial practices. Technical and legal changes also have an impact, for example, in England between 2008 and 2010 the total pesticide application rate on cereals decreased by 23% largely due to dramatic changes in herbicide use; older chemicals were revoked and replaced with active substances requiring lower application rates (DEFRA et al., 2013).

In the United Kingdom, the majority of agricultural abstraction and irrigation takes place in the South East and East of England. Such abstraction can be locally important, putting pressure on overall **water quantity** and aquatic habitats. While the total amount of water withdrawn for agriculture has reduced by 4% over 1990/92 to 2006/8, there has been an increase in agriculture's share of total freshwater withdrawals from 12% to 15% over 1990/92-2006/8 (OECD, 2013a).

Soil losses from cultivated and other land are generally low in the United Kingdom. However, soil erosion (principally water erosion rather than wind erosion) can occur in some localities, with about 17% of the United Kingdom (OECD, 2013a), and 25% of England and Wales being at moderate to very high risk, predominantly arable and rough grazing land (OECD, 2008). Soil loss can exceed 100 tonnes/hectare in some places. The main causes of soil erosion are related to land left uncovered over winter, the use of heavy machinery and areas subject to high livestock pressure. Soil organic matter has decreased by an average of 0.5% over 1979/81-1995 (EA, 2004). **Soil quality** has been a focus of agri-environment and related schemes in the United Kingdom in recent years.

There is limited data on **carbon storage**, however data for England shows a decline in arable and horticulture soil carbon storage over 1978-2007 (DEFRA, 2013a). Soils are the largest terrestrial store of carbon; globally soils contain about twice as much carbon as the atmosphere and about three times the carbon stored in vegetation. Losses of soil carbon, partly through soil erosion and loss of soil organic matter (OECD, 2008b), contribute to greenhouse gas emissions, in the form of carbon dioxide.

Greenhouse gas emissions from agriculture in the United Kingdom have decreased in recent years. Both the two key agricultural greenhouse gases – nitrous oxide and methane – have decreased by around 20% between 1990 and 2010 (OECD, 2013a) with the relative contribution from nitrous oxide and methane remaining the same (approximately 61% and 39% respectively). The reduction in nitrous oxide is consistent with trends in fertiliser usage over the period, while the reduction in methane has been due to decreasing livestock numbers, particularly cattle. However, with total emissions across the country also falling, agriculture's share of greenhouse gas emissions has actually increased slightly from 7.5% to 7.7% over 1990/2-2008/10. Agriculture remains

the major source of nitrous oxide and methane emissions in the United Kingdom. In 2011 agriculture accounted for 84% of total nitrous oxide emissions and 43% of total methane emissions in the United Kingdom (DEFRA et al., 2013).

Air quality associated with agriculture in the United Kingdom has improved. Ammonia is the key pollutant associated with agriculture, and ammonia emissions have decreased by 24% over 1990-2011 (OECD, 2013a and DEFRA et al., 2013). While agriculture remains the main source of ammonia, its share has reduced over the same period from 93% in 1990 to 86% in 2011. Livestock production, mainly cattle, is the major contributor and the reduction in ammonia emissions is largely due to reduced cattle numbers and more efficient fertiliser use.

There is limited agri-environment data in the United Kingdom relating to **resilience to natural disaster** such as flooding and fire**.** However, there is some evidence to suggest a reducing trend in the hazard regulating service provided by farmland, including resilience to flooding and potentially fire (UKNEA, 2011). Improving agri-environmental data and monitoring in these areas would be beneficial.

4.3. Drivers causing changes in United Kingdom agri-environmental public goods and market failure

While the demand or need for agri-environmental public goods is increasing, evidence suggests that there is a mixed picture in terms of supply. Some agri-environmental public goods show an improvement in supply (water quality, reduction of greenhouse gas emissions, and air quality), while others appear to be deteriorating (biodiversity, soil quality) or mixed (agricultural landscapes, water quantity). This could be a reflection of the difficulty in reversing negative trends in biodiversity, for example, and the time required to achieve this, but it could also relate to an under-provision of certain public goods, potentially linked to the funding and delivery mechanisms available.

Agri-environment public goods are influenced to an extent by a reduction in the agricultural area and a decrease in agricultural production (both crop and livestock) (Section 3). However the specialisation and intensification of farming is also very important; there has been a decline in enterprise diversity in farming systems, more intensive management practices and, despite recent falls, still relatively high levels of chemical inputs. These have tended to adversely affect the supply and quality of agri-environmental public goods such as agricultural landscapes, biodiversity, water and soil. A shrinking and ageing agricultural labour force has also had an impact on the maintenance of certain farming systems, management practices (e.g. cattle grazing, shepherding and (controlled) burning on moorland) and infrastructure (e.g. the maintenance of hedges and dry stone walls) which are beneficial for agri-environmental public goods such as landscape and biodiversity. Other influences include animal disease, which has affected the number of cattle in extensive grazing livestock systems with an effect on a number of public goods provided by agriculture, biodiversity being the principle one and climate change, which in turn affects water quantity and resilience to flooding and fire.

Even taking the above into account, the biggest challenge relating to the provision of agri-environmental public goods in the United Kingdom is that farmers do not have the incentive to provide these goods due to the lack of markets. If there were enough private benefits for providing agri-environmental public goods, farmers could provide them without public support. However, with limited or no private benefits, some form of public intervention is required in order to secure the provision of agri-environmental public

goods, at the scale required to match the demand and need (Pannell, 2008; Cooper et al., 2009; OECD, 2010a). In order to address these issues, and provide agri-environmental public goods now and in the future, the United Kingdom, through its devolved governments has been at the forefront of developing and implementing various agri-environmental policies. Since many factors affecting the provision of agri-environmental public goods are drivers (input based or means), most United Kingdom agri-environmental policies target the means rather than directly target the ends (agri-environmental public goods). United Kingdom agri-environmental policies are discussed in Section 6.

In concluding this section, it is worth restating that the lack of markets is the key factor influencing the supply of agri-environmental public goods and this is addressed, to a significant extent, by publicly-funded schemes and programmes. There is always scope for government to do more of course, in areas such as biodiversity and climate change, for example, in line with evolving priorities at both EU and UK levels. Importantly, the private sector can also do more, and there is an increasing recognition of the value of public goods to businesses and consumers, and a variety of mechanisms are in place and being developed to deliver these, for example through Payments for Ecosystem Services schemes (see Section 6.3).

5. Reference levels and agri-environmental targets of agri-environmental policies

Government intervention may be necessary in the case of market failure. However, questions remain about the extent to which government should intervene. In order to consider this point, a framework about reference levels and environmental targets is useful (OECD, 2001, 2010b).

Environmental reference levels are defined as the minimum level of environmental quality that farmers are obliged to provide at their own expense; reference levels can be set in terms of environmental outcome or appropriate farming practice. Environmental targets, on the other hand, are defined as minimum (mandatory) levels of environmental quality for the agricultural sector in a country or desired (voluntary) levels of environmental quality that go beyond minimum requirements. Environmental targets depend on society's preferences for environmental quality while reference levels depend on the country's traditions or laws in defining property rights.

In the United Kingdom (and wider EU), the environmental reference level is either enshrined in legislation setting out legal requirements in relation to minimum standards which must be adhered to by law, or is expressed in standards of good agricultural practice which, although not enforceable in a legal sense, are practices that are expected of all farmers (DEFRA, 2009). The legislative baseline specifies those actions which are compulsory for the farmer to undertake and for which he/she should bear the cost. In most cases, EU legislation is in the form of Directives, which provide a broad framework for transposition into national law and implemented at Member State level. Many of these national legislative requirements are included within the mandatory Good Agricultural and Environmental Conditions (GAEC) standards under cross compliance (Cooper et al., 2009).

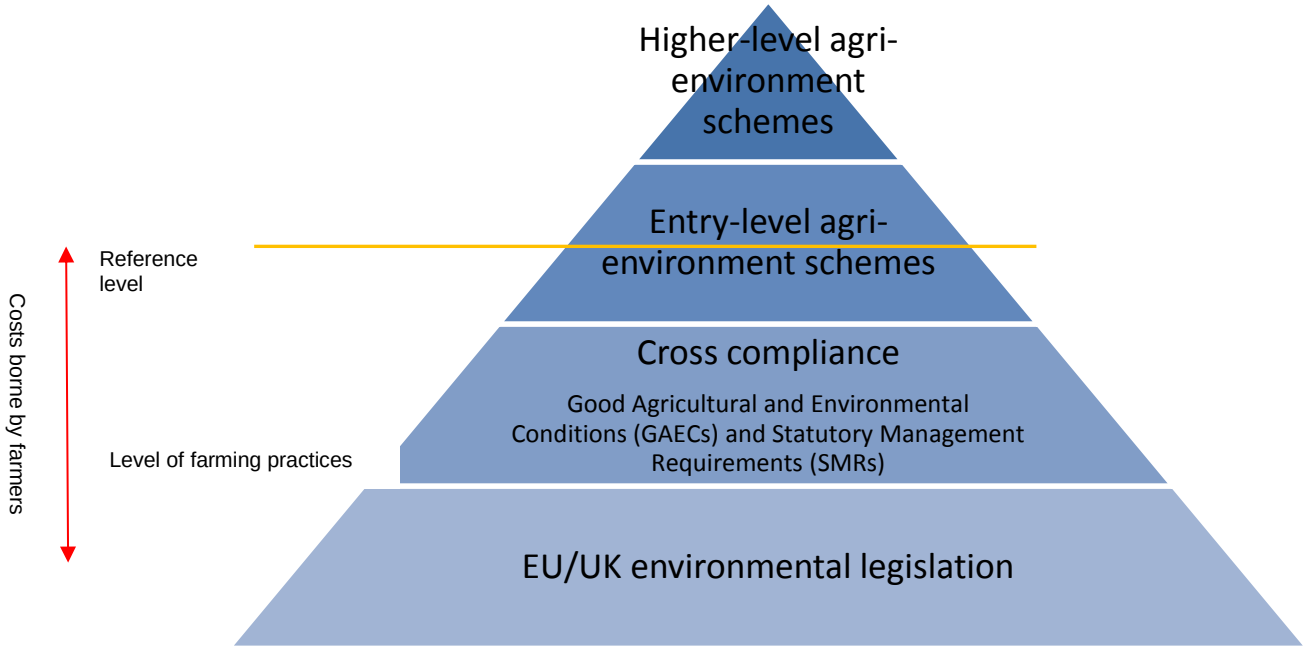
Figure 4 illustrates the environmental reference levels in the United Kingdom and corresponding farming practices and policy mechanisms. Table 5 complements this diagram by showing reference levels and environmental targets for specific agri-

environment public goods in the United Kingdom (Annex Table 1 provides a more detailed description of reference levels and environmental targets).

For biodiversity, water quality, water quantity, soil quality and air quality, there are both specified reference levels and environmental targets. For these public goods, the reference levels relate to cross compliance while the targets are based on international or EC commitments. These commitments are informed by and based on scientific evidence (e.g. water quality).

For some other agri-environmental public goods, it is not possible to identify specific reference levels. In these cases, there are no EU or national legislative requirements and the current farming practices effectively comprise the reference levels. Therefore, if a programme requires farmers to improve the environment associated with agriculture to achieve environmental targets, there may be a need to provide environmental payments (or some other form of incentive or support), since farmers have already achieved what they have to do. That said, many farmers in the United Kingdom undertake to meet conditions set by cross compliance as part of their participation in direct payment, LFA and agri-environment schemes. These farmers may have to bear some costs to improve the environment, beyond current farming practices, until they meet cross-compliance conditions.

Figure 4. Agri-environment reference levels and policy mechanisms in the United Kingdom



When agricultural activities result in negative externalities, such as pollution (e.g. soil, water and air pollution), the Polluter Pays Principal (PPP) applies and farmers are obliged to meet the reference level at their own expense. On the other hand, when farmers provide public goods (e.g. agricultural landscape, biodiversity), current farming practices tend to be equal to reference levels (or some programmes require to meet cross-compliance), and environmental payments are used to achieve environmental targets. It is worth noting that

societal welfare can still be improved through payments to reduce polluting activities through agri-environment schemes, for example.

Reference levels are not always equal to regulation levels. Sometimes, regulation levels can be set beyond reference levels. In these cases, governments may choose to provide payments to help farmers meet the regulation levels (Case B of Figure 5). For example, to improve water quality and mitigate environmental problems associated with livestock, farmers are required to install suitable facilities to store livestock manure and slurry. The devolved authorities provide technical advice and assistance, and in some cases grant aid, to help farmers meet the enhanced standards.

With regard to environmental targets, some agri-environmental public goods do not have explicit targets in the United Kingdom. This may be because it is difficult for some agri-environmental public goods to have quantitative targets (e.g. agricultural landscapes or resilience to fire), or because issues are relatively new (e.g. carbon storage). Environmental targets, ideally, should try to improve the environment; however, maintaining the current level of provision could also count as an environmental target given the deterioration in the quality and quantity of some agri-environmental public goods.

Table 5. Summaries of reference levels and agri-environmental targets in the United Kingdom

	Agri-environmental public goods				
	Agricultural landscapes	**Biodiversity**	**Water quality**	**Water quantity/ availability**	**Soil quality and protection**
Environmental targets	Integration of landscape into policy under European Landscape Convention	UK Post 2010 Biodiversity Framework and individual country Biodiversity Strategies, linked to EU Biodiversity Strategy	Good ecological status in all water bodies by 2015 under EC Water Framework Directive	Sustainable use of water and drought mitigation under EC Water Framework Directive	Sustainable use of soil under EC Soil Thematic Strategy-
Reference level	GAECs under cross compliance	GAECs and SMRs (1, 5) under cross compliance	GAEC and SMRs (2,4) under cross compliance	GAEC under cross compliance; Water Resources Act	GAECs and SMRs(2,3,4) under cross compliance

	Agri-environmental public goods				
	Climate change-Carbon storage	**Climate change-Greenhouse gas emissions**	**Air quality**	**Resilience to natural disaster**	
				Flooding	**Fire**
Environmental targets	Sustainable use of soil under EC Soil Thematic Strategy and protect soil as a carbon store under Kyoto Protocol	25% reduction by 2030 (CCC, 2013)	Emissions limits under EC National Emission Ceiling Directive & UK Air Quality Strategy	Reduce probability of flooding under EC Flood Directive	-
Reference level	Current farming practices are equal to reference levels	Current farming practices are equal to reference levels	GAECs and SMRs (3,4) under cross compliance, IPPC requirements	Current farming practices are equal to reference levels	Current farming practices are equal to reference levels

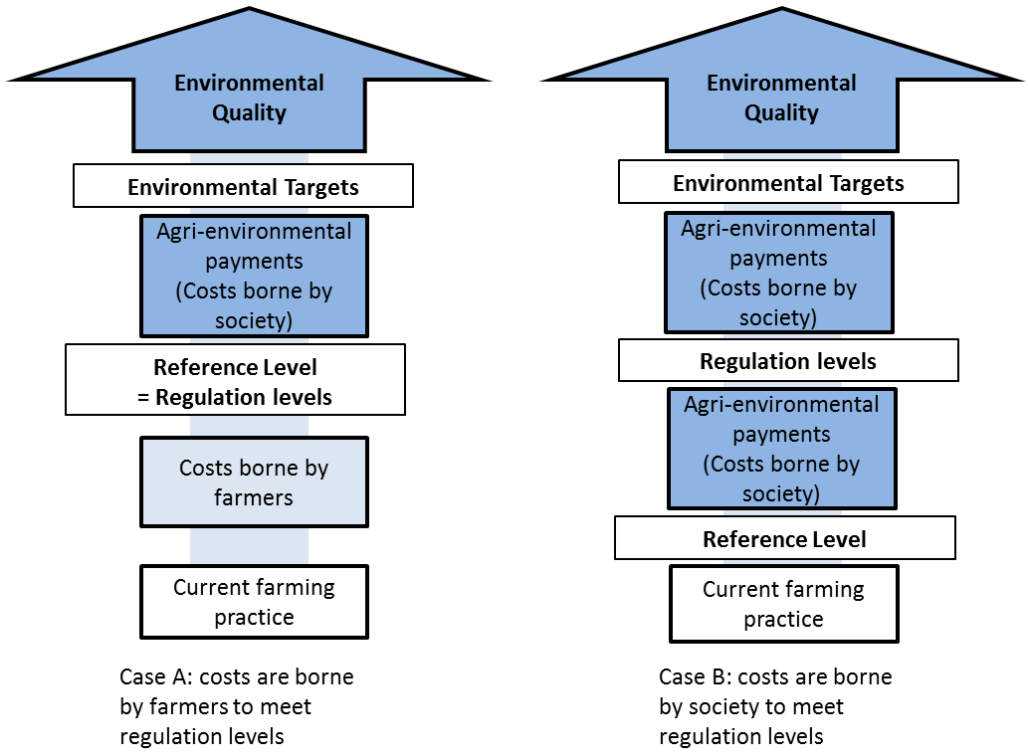
The environmental targets and reference levels are set by the Government and/or devolved authorities, and informed by international and EC commitments and policies, scientific evidence, expert analysis and public consultation. For many agri-environment public goods, this process takes place in the context of the development of the Rural

Development Programmes (RDPs) for the countries. The RDPs for 2014-2020 are being developed presently.

Environmental targets and reference levels are not set out clearly for all agri-environmental public goods in the United Kingdom. Ideally, environmental targets should be output based or directly related with the status of agri-environmental public goods provided. However, in many cases, proxy indicators (e.g. area of utilisable agricultural area subject to agri-environment scheme agreements) are used. In addition, in some cases, there are no quantitative targets, and instead, qualitative targets are set. This makes it difficult to evaluate policy measures. Even if there are overall environmental targets (e.g. preserving biodiversity), it is not clear to what extent each policy measure (e.g. direct payments for environmentally friendly farming) tries to address the targets, and to what extent other policy measures try to contribute to achieve the targets. Agri-environmental targets and reference levels are necessary to develop better policy measures and to identify better cost-sharing between farmers and the society.

Once environmental targets and reference levels are set out, to provide agri-environmental public goods, policy intervention may be necessary. Current United Kingdom policy measures for agri-environmental public goods are reviewed in the next section.

Figure 5. Reference levels and agri-environmental targets



6. Policy measures for agri-environmental public goods

The most important agri-environmental policy measures in the United Kingdom include regulations, payments and technical assistance (OECD, 2010c). Table 6

summarises the relative importance of agri-environmental policy measures in the United Kingdom. Policy measures targeting land retirement, farm fixed assets and tradable rights are used but are rather limited in scope to date. Environmental taxes, payments based on outcomes, and community-based measures are not implemented or at an early stage of development. This section focuses on 1) regulatory measures, 2) financial incentives and 3) facilitative measures and then 4) discusses how these measures target agri-environmental public goods in the United Kingdom. The review is just of existing measures with some reference to past programmes that still have some influence. This includes agri-environment programmes that normally run for five or ten years and thus take some time for the last of the existing schemes to expire even after they are closed to new entrants.

Table 6. Overview of Agri-environmental Policy Measures in the United Kingdom

Measure/Country	Importance
Regulatory measures	
Regulatory Requirements	XX
Environmental taxes/charges	NA
Environmental cross-compliance	XX
Financial incentives	
Payments based on farming practices	XXX
Payments based on land retirement	X
Payments based on farm fixed assets	X
Payments based on outcomes	NA
Tradable rights/permits	X
Community based measures	NA
Facilitative measures	
Technical assistance/extension	XX

NA-not applied or marginal; X-low importance, XX-medium importance, XXX-high importance.

Source: Adapted from OECD (2010c), "Policy Measures Addressing Agrienvironmental Issues", *OECD Food, Agriculture and Fisheries Papers*, No. 24, OECD Publishing, Paris.

Coverage does not include future programmes and upcoming legislative programmes. There are important changes due to take place. The most important of which are changes to the CAP. It is clear that there will be significant changes in the agri-environment programmes in all parts of the UK. This is partly in response to CAP reform but it would in any event have been an appropriate point to make changes as a result of reaching the end of the six year rural development programming period. The most significant changes as a result of the reform are: the creation of the greening measures to accompany Pillar 1 direct payments, the revision of the aims and structure of Pillar 2 and new conditions on the movement of funds between pillars 1 and 2 and co-financing conditions.[7] These are

7. The implementation of the new CAP for the period 2014-2020 continues the greening process of the agricultural sector. It requires that farmers wishing to make use of direct payments to put greening measures in place that were agreed to at the European level. They include:

- Crop diversification: Farmers will be required to grow at least three crops on their arable land, with exceptions made for farms with small areas of arable land.
- Maintenance of permanent grassland:

all significant developments. We are not including coverage of them within this study partly because, while the EU framework is now clearer, implementation of the reforms in the UK is still uncertain, and partly for the sake of brevity because the policy environment is already quite complex within the UK based on the devolved regional framework and the range of measures in use.

6.1. Regulatory measures

Regulatory measures in the United Kingdom include those regulations included within environmental cross compliance and others. Cross compliance is within a framework of the CAP and presumes involvement in the Single Payment Scheme (SPS). The implementation of SPS and participation rates vary across the UK. In England the SPS is delivered on an area basis which means that all farmers had the opportunity to register their land area for entitlement in 2005. Most of that land was then claimed on in 2005 (99.1%) although this has fallen slightly subsequently to 97.7% and 3.3% of entitlement is not used to make claims ("Indicator A1: Single Payment Scheme uptake" cited in DEFRA, 2010a). In Scotland and Wales SPS entitlement is related purely to individual coupled payment claim "history" in the reference period 2000-02 and was only issued to farmers who were coupled payment claimants. This has meant that the claim area is significantly smaller than the potential area for claims. There are around 18 828 producers in Scotland claiming SPS (Scottish Government, 2010) but there are 52 625 holdings (Scottish Government, 2013a). It is estimated that only about half the rough grazing in Scotland is subject to cross-compliance conditions (see Box 4 and European Court of Auditors, 2011). This limits the reach of cross-compliance and this is a matter for concern (Scottish Government, 2010). In Northern Ireland a hybrid system operates which includes an element of flat rate in the payment structure which encourages greater reach but to a lesser extent than the flat rate only situation in England.

Box 4. The tension between policy objectives for LFA Rural Development payments and CAP Pillar 1 decoupled support in the United Kingdom (Scotland)

"The provisions concerning GAEC have a considerable impact in the United Kingdom (Scotland), where the major part of agricultural land is rough grazing land, nearly half of which is declared under the SPS. Most of this land is situated in LFAs. The applicable national rules for LFAs require that the land be actively farmed. In contrast, under the SPS the same land is eligible on the sole condition that claimants commit themselves not to carry out specific activities that would change the natural state of the land e.g. drainage works or ploughing. The Court identified individual beneficiaries in receipt of between several hundred thousand and up to more than 1 million euro per year in SPS aid without having any agricultural activity on such land, including a nature reserve which for decades has not been used for farming. It is estimated that SPS aid is currently paid in relation to approximately 150 000 hectares of such parcels." European Court of Auditors (2011, p. 25)

A broad range of controls exists on land use planning and environmental controls. The most specific and significant environmental controls on agriculture are picked up in cross compliance requirements under the SPS. These vary to some extent at regional level across the United Kingdom however they are broadly similar. They comprise Statutory Management Requirements (SMRs), Good Agricultural and Environmental Conditions

- Ecological Focus Area (EFA): Farmers will be required to designate 5% of their arable land as an EFA, with exceptions for farms with small areas of arable land. These areas include landscape elements (e.g. wooded banks, hedgerows, and ponds), field margins, buffer zones and land with nitrogen fixing crops.

(GAECs) and permanent pasture preservation rules. SMRs are based on EC Directives and are thus backed up by legislation affecting all farmers not just those in SPS. GAECs are subject to greater Member State discretion and there is more scope for subsidiarity. Thus for example the inclusion of public rights of way as a GAEC requirement (GAEC 8 in England) is a feature not found in many other EU Member States. Permanent pasture preservation rules have a fixed aim but discretion at Member State and regional level in how to achieve it. The SMR and GAEC cross compliance requirements in England are shown in Table 7.

Table 7. GAECs and SMRs in the United Kingdom (England)

Good Agricultural and Environmental Conditions		Statutory Management Requirements	
GAEC 1	Soil Protection Review	SMR1	Wild birds
GAEC 5	Environmental Impact Assessments	SMR2	Ground Water
GAEC 6	Sites of Special Scientific Interest	SMR3	Sewage sludge
GAEC 7	Scheduled Ancient Monuments	SMR4	NVZs (Nitrate Vulnerable Zones)
GAEC 8	Public Rights of Way	SMR5	Habitats/Special Protection Areas
GAEC 9	Overgrazing & supplementary feeding	SMR6	(SPAs) Pig identification and
GAEC 10	Heather and grass burning	SMR7	traceability
GAEC 11	Control of Weeds	SMR8	Cattle identification and traceability
GAEC 12	Land which is not in agricultural	SMR9	Sheep and goat ID & traceability
GAEC 13	production Stone walls	SMR10	Plant protection products
GAEC 14	Protection of hedgerows and	SMR11	Hormones in animals
GAEC 15	watercourses	SMR12	Food and animal feed safety
GAEC 16	Hedgerow maintenance	SMR13	BSE prevention
GAEC 17	Felling of trees	SMR14	Foot and Mouth Disease (FMD)
GAEC 18	Tree Preservation Orders	SMR15	prevention
GAEC 19	Water abstraction	SMR16	Swine Vesicular Disease (SVD)
	No spread zones	SMR17	prevention
		SMR18	Blue tongue disease prevention
			Pig animal welfare
			Calves animal welfare
			Farmed animals welfare

Much of the SMR coverage relates to regulating agricultural production for the purpose of disease control, traceability and welfare. The environmental aspects are mainly to do with pollution control with respect to water (SMR3 and SMR4), use of agricultural land to dispose of sewage (SMR3) and control of the use of agri-chemicals (SMR9) and protecting wildlife and habitats (SMR1 and SMR5). Legislation protecting special designated areas recognised at national and EU level as key habitats for wildlife is included (SMR5). The importance of birdlife, in particular, as part of farmland ecology at United Kingdom and EU level, is evidenced by the inclusion of general requirements to protect wild birds (SMR1).

GAEC cross compliance requirements are mostly supportive of legal requirements imposed on all farmers. The exceptions are the soil protection review (GAEC 1), prevention of overgrazing and unsuitable supplementary feeding on natural grassland (GAEC 9), minimum standards of maintenance (by cutting or grazing) on land not in agricultural production (GAEC 12) and the non-removal of stone walls as traditional man made landscape features (GAEC 13). The Soil Protection Review is self-regulatory in that farmers are required to make their own assessment of field by field risks and adopt their own management practices. However they are also bound by requirements that prohibit the trafficking of water logged soil and harvesting under such conditions. It also includes a mandatory requirement not to burn crop residues which extends beyond cross compliance. In addition to SMRs and GAEC requirements there is a cross compliance limitation on the ploughing up of permanent pasture (i.e. land in grass for more than

5 years). This also has statutory backing and a requirement to complete an Environmental Impact Assessment should self-assessment criteria deem this necessary.

There are further regulatory measures beyond cross compliance. These include, for example, special conditions which are attached to large intensive livestock units (i.e. over 40 000 places for poultry, 2 000 places for production pigs (over 30 kg) and/or 750 places for sows) which require a permit to operate (EA, 2010). There are added general restrictions on development within Areas of Outstanding Natural Beauty (AONB) and National Parks which override some of the exceptions that are generally granted to agriculturally related development and activities. Farmers and land managers with land designated as a Site of Special Scientific Interest (SSSI) – representing the country's very best wildlife and/or geological sites –are required to manage this land in a way which maintains or enhances its special interest and avoids damaging this.

6.2. Financial incentives

Financial incentives concentrate particularly on agri-environment schemes and these are well developed and widely used in the United Kingdom. They all include as a baseline the requirements under SPS cross compliance and good agricultural practice codes. However the programmes are different in each part of the United Kingdom and funding levels and priorities also differ regionally. In England Pillar 2 Rural Development measures are supported by 19% modulation of funds from Pillar 1 whereas in Scotland the figure is 14% and in Wales 11.5% (ABC, 2013). Agri-environment support is mostly funded through Axis 2 of Pillar 2 of the CAP. Programme balance stipulations place the maximum amount of funding in Axis 2 at 80% and a minimum of 20%. In England Axis 2 spending is at the maximum 80% level (EC, 2007a). In Wales spending is about 72% (EC, 2008a) and in Scotland it is only 69% (EC, 2008b). In Northern Ireland the priority is lower still at 58% in Axis 2 funding (EC, 2007b). Thus in England agri-environment schemes benefit both by the diversion of more funds from Pillar 1 and a greater emphasis within Pillar 2 funding than is the case elsewhere in the UK.

Agri-environment is mostly contained within the Environmental Stewardship (ES) Scheme in England. This has been operational since 2005 and replaced the Countryside Stewardship Scheme (CSS), the Organic Farming Scheme (OFC), the Environmentally Sensitive Area (ESA) scheme and the Wildlife Enhancement Scheme (WES). It operates at two levels: Entry and Higher (see Figure 4). The Entry Level is based on a set payment on a per hectare basis. Points are amassed from a menu of good environmental practices aimed mostly at biodiversity and wildlife. The point scores are set within EU defined payments rules which largely restrict them to no more than the income foregone and costs incurred (plus up to 20% for transaction costs). The aim of the scheme is widespread inclusion and low administration costs. Acceptance is automatic for any farmer who has fulfilled the criteria.

Entry Level payments can be enhanced where land is farmed under organic rules. This doubles the payment from GBP 30/hectare to GBP 60/hectare. Farming land organically qualifies for an extra 30 points therefore there is nothing extra that the organic farmer needs to do to achieve the increased points target. In addition a grant is paid towards the cost of conversion to organic for the first two years. There is also an upland top-up to the basic ELS payment. However points for this must be earned from a menu of good environmental practices geared specifically to the uplands. Thus, for example, collaborating with neighbours to organise and restrict grazing on common land is awarded points. Some of the upland prescriptions also relate to upland landscapes such as

restoring stone walls and old barns. Farmers in the uplands who farm organically can benefit from both forms of top-up to the basic payment. Because entry level payments are based on a fixed and relatively low area payment, uptake is skewed towards larger farms, extensive farming and farmers qualifying for the upland and organic top-ups and away from the smaller farms and particularly the intensive livestock and horticultural types.

The Higher Level goes above and beyond Entry Level i.e. all Higher Level agreements must have an Entry Level component. Payments are still based on a menu of options with fixed standard payments. But the payments are actual and not via a points system and there is no fixed or upper limit on an area basis other than those set by the EU payments regulations. The range of activities is much wider and more bespoke to specific situations and habitats e.g. parkland trees or chalk downland native flora. Capital works can be grant funded under HLS. Aims are broader and more ambitious and the biodiversity survey work is much more detailed. These aims have been nuanced to particular target areas so that plans that include say habitat for particular bird species or traditional landscape features that are native to the area or important archaeological protection will be favoured. Farmers need to come up with plans that are attractive when measured against these aims as the funding is restricted and accessing it is competitive. The HLS remit includes public access and education. There are also more options within historic features and landscape and soil and water protection than would be the case at Entry Level.

Other schemes to provide environmental public goods outside Environmental Stewardship in England include the England Catchment Sensitive Farming Scheme Delivery Initiative (ECSFDI). This is jointly managed between the Environment Agency and Natural England and is aimed specifically at improving water quality. It offers grants for capital works to restrict or avoid water pollution. This includes, for example, providing dirty water collection facilities on dairy farms, separate drinking facilities for stock and fencing to keep them away from water courses. It has been targeted at a local or water catchment level and priority has been given to farms prepared to join ES. The Farming and Forestry Improvement Scheme (FFIS) is also used to provide grants linked to soil quality (e.g. aeration) and water quantity (e.g. rainwater harvesting). Woodland planting and the conversion of agricultural land to woodland have been encouraged under the English Woodland Grant Scheme (EWGS). The growing of energy crops with aims towards renewable energy supplies and carbon capture has also been encouraged under an Energy Crop Scheme (ECS) with the main forms of biomass being *miscanthus* and the short rotation coppice of certain tree species (mainly willow).

The Scottish equivalent of Environmental Stewardship is the Rural Development Contracts Scheme (ABC, 2013). Like the English scheme, this is designed to go beyond the basic requirements of SPS cross compliance (which in the Scottish scheme is referred to as Tier I). Tier II "Land Managers Options" have basic flat rate payments ceilings rather than targets. These are scaled based on size so that the first 10 hectares is at GBP 75/ha, 10 to 100 ha is at GBP 30/ha (on a par with the English ELS) but it then drops to GBP 1/ha up to 1 000 ha and then to only GBP 0.1/ha above that. Options to reach the target include some elements that are not environmental public goods such as skills training and investment in electronic data management. Tier III "Rural Priorities" is more equivalent to HLS. Organic farming support is treated separately under the Organic Support strand of the Rural Development Contracts Scheme.

In Wales, four previous agri-environment schemes (Tir Gofal, Tir Cynnal, Tir Mynydd and the Organic Farming Scheme) were replaced by a new programme called

Glastir (ABC, 2013); Glastir was initially launched in 2009 and then re-launched as a more comprehensive scheme in 2012. Glastir Entry is the ELS equivalent but, like the Scottish Land Managers Options, it is not an exact equivalent. There is a Whole Farm Code (WFC) with 13 elements and then selected options to meet a target much as in ELS. Like the Scottish scheme payments are progressively reduced with increasing farm size. Glastir Advanced is the HLS equivalent and works in much the same way but with a different menu of options and more emphasis on issues such as soil carbon conservation than is the case in the English scheme. Glastir Woodlands is directed at woodland creation (much the same as the EWGS). Glastir Efficiency Grants are only available to those in Glastir Entry. It is aimed at renewable energy and water conservation. Glastir Commons aims to spread environmental benefits to the management of common land and requires collaboration from at least 80% of the graziers. This resonates with options within UELS but it is more specially targeted towards the specific circumstances of common land.

The Northern Ireland Countryside Management Scheme (NICMS) is not really equivalent to any of the programmes running in other parts of the United Kingdom but includes elements of them. Thus it has whole farm compulsory elements (like Glastir Entry) but it also has Minimum Entry Environmental Benefit which is adaptable. Farmland habitats and features are core elements, while Habitat Enhancement and Enhancement Measures equate to HLS and its capital works. Outside NICMS there is a New Environmentally Sensitive Area Scheme (NESAS) which is a continuation of the type of scheme that was superseded in England and a separate Organic Farming Scheme (OFS). Uptake of these schemes has been much lower in Northern Ireland than is the case in England. The three schemes together cover 440 000 hectares which is only 40% of the farmed area of Northern Ireland (NISRA/NIEA/NOENI, 2013). There are woodland schemes in Northern Ireland. Much of the woodland (70%) is in state ownership but on the remainder in private ownership the state Forestry Services offers grant support to create new plantings. These amounted to only 313 hectares in 2011/12.

6.3. Facilitative measures

In England, there has been an initiative aimed at getting farmers involved with good environmental practices without necessarily seeking support from agri-environment programmes (although this is not discouraged). The Campaign for the Farmed Environment (CFE) has received support from farmer and land owner representative bodies. The CFE claims to have succeeded in attracting recognition by two thirds of lowland farmers and that 45% of lowland holdings had land within one of the 22 listed financial incentives in a survey in March 2013. Based on the survey it is estimated that there are "677 000 hectares managed under the listed unpaid environmental measures with an additional 6 778 skylark plots and 6 781 km of fenced watercourses. Over wintered stubbles accounted for the greatest area (266 000 hectares), followed by fertiliser free permanent pasture (232 000 hectares)" (DEFRA, 2013d).

The Farm Advice Service (FAS), which is funded by DEFRA, offers support to farmers most of which is related to delivery of environmental public goods i.e. cross compliance, nutrient management, climate change adaptation and mitigation. There is an element that supports their ability to run their businesses efficiently and competitively but this is relatively small in comparison. Natural England runs the ELS Training and Information Programme (ETIP) which provides advice to farmers to improve uptake of priority options under ELS (e.g. those which benefit farmland birds) and promote best practice.

The Environment Agency supports various initiatives to encourage farmers to adopt good environmental practices and has tried to do so by illustrating ways in which it can improve the efficiency and profitability of their business as well as achieve environmental gains. 15 case studies of win-win approaches are featured in EA (2008). The areas concentrated upon are using water wisely, combating floods, soils, nutrients, crop protection, maintaining crop cover, managing grassland and boundary features to retrain soil, pollution from manures, tracks, ditches and riverbanks, waste products and energy saving.

Similar advisory schemes, to those mentioned above, operate in Wales, Scotland and Northern Ireland.

Harder to identify and quantify is the influence that environmental lobby groups have, both directly and indirectly and the increasing influence of pressure within the food supply chain from retailers back to farm level. Both are important in the UK. Some environmental organisations are substantial landowners in their own right, see Box 3. UK food retailing is very concentrated and competitive and supermarkets generally and especially those aiming at higher income consumers have emphasised environmental credentials in procurement. This sends strong messages to producers. The Waitrose supermarket chain, for example, has a strong link with the LEAF organisation (Linking Environment and Farming); all Waitrose's UK grown fresh produce is certified by LEAF Marque – a global assurance system recognising sustainably farmed products – and the retailer has a commitment to source 100% of its UK grown oilseed rape and wheat from LEAF Marque growers (LEAF, 2013). Similarly, the UK's largest supermarket, Tesco, ensures that all its fruit and vegetables are grown to high environmental and responsible standards through its own, independently accredited Nurture scheme; this scheme now has 15 000 growers across 70 countries (Tesco, 2014).

6.4. Agri-environmental public goods and policy measures

Table 8 summarises agri-environmental policy measures in the United Kingdom and links them to their targeted agri-environmental public goods. Some are quite specific and relate to only one agri-environmental public good. Thus for example ECSFDI relates only to water quality. Others are multi-purpose. The best example of these are the most demanding higher level agri-environment schemes, like the HLS in England, which has aims virtually across the full spectrum of agri-environmental public goods. The picture is complicated by the devolved regional structure of government. Although they are broadly similar in approach and balance between measures, at a detailed level there are more differences, even with the application of cross compliance measures under the SPS, than one might think would be the case.

The emphasis in the UK is mainly in a balance between regulation, much of which is drawn together and given added force by being included in cross compliance, and voluntary agri-environment scheme measures. Both are about to be altered by the reform of the CAP but the new measures are not yet finalised and have not been covered in this section. In most respects the changes will be evolutionary rather than revolutionary but it will alter the balance between regulatory and financial incentives somewhat.

The main regulatory measure is cross compliance linked to the SPS. But it is largely a collection of regulatory measures that apply to all farmers and not just those in SPS. Cross compliance has its greatest influence over agricultural landscapes, bio-diversity, soils and water quality and quantity. There are some farmers not in SPS and therefore not subject to cross compliance currently, particularly in Scotland and Wales, because SPS is

focused on those with a history of claims in the production support era. However following CAP reform farmers will receive flat rate payments regardless of previous claims history (as is the case in England) and the influence of cross compliance will then be virtually universal.

Agri-environment schemes are well-developed and well-funded thanks mostly to the use of modulated funds removed from Pillar 1 direct payments. This is particularly the case in England where the modulation rate is significantly higher than in other parts of the United Kingdom. At an operational level there are a number of differences between the agri-environment schemes in the four regions of the UK. But a common theme is a two level structure with a "broad and shallow" component and a higher level which is more targeted, specialised and sophisticated. The lower level is designed to exceed the requirements of cross compliance but to have limited aims within a simple structure, for widespread adoption and based mainly on self-administration by the farmer. The higher level is more demanding on both the farmer and the administering authority. The approach is bespoke and carefully targeted. Inclusion is competitive for restricted funds and hence it is for selected farms only. The ambition and the ability to target programmes is much greater at the higher level. Wide participation in the lower level gives inclusiveness but the approach has been criticised for allowing too much deadweight (Hyder Consulting (UK) Ltd, 2010) and the lower level approach may become replaced by greater regulatory control following CAP reform.

In additional to publicly funded schemes, there is increasing interest in the emergence of privately funded Payment for Ecosystem Service (PES) schemes in the United Kingdom. Several pilot schemes are operating, mainly by water companies in upland areas. Examples include: the Sustainable Catchment Management Programme (SCaMP) run by United Utilities in the Peak District, which is restoring blanket bog, upland heathland and upland oakwood habitats to help protect water quality and quantity and reduce water treatment cost; and the "Upstream Thinking" initiative run by South West Water on Exmoor and Dartmoor, which aims to improve land management and restore wetland habitats to improve water quality and quantity at source (Cumulus Consultants, 2013). Both schemes involve water companies entering into agreements directly with farmers, usually complementing publicly funded agri-environment scheme agreements.

Table 8. Agri-environmental Policy Measures in the United Kingdom

AE public goods		Measures									
		Regulatory			Financial incentives						Facilitative
		Regulatory require-ments	Environ-mental taxes/ charges	Environ-mental cross-compliance	Payments based on farming practices	Payments based on land retirement	Payments based on farm fixed assets	Payments based on outcomes	Tradable rights /permits	Community based measures	Technical assistance/extension/R&D/labelling/standards/certification
Agricultural landscapes				CC	ES, Glastir, RDC, NICMS	EWGS, Glastir, RDC, WGS	RDC				FAS, FATI/ETIP, FC, WFR, CAFRE
Biodiversity		WCA, CROW, WBD, HD		CC	ES, Glastir, RDC, NICMS	EWGS, Glastir, RDC, WGS					FAS, FATI/ETIP, FC, WFR, CAFRE
Water quality/ availability		WRA, ND, IPPCD, WFD		CC	ES, Glastir, RDC, NICMS	EWGS, Glastir, RDC, WGS	ECSFDI, Glastir, RDC, FMP				FAS, FATI/ETIP, FC WFR, CAFRE
Water quantity		WRA		CC			FFIS		Water rights trading		FAS, FC, WFR, CAFRE
Soil quality and protection				CC	ES, Glastir, NICMS		FFIS				FAS, FATI/ETIP, FC, WFR, CAFRE
Climate change – carbon storage					ES, Glastir, RDC, NICMS	EWGS, Glastir, RDC, WGS					FAS, FC, WFR
Climate change – greenhouse gas emissions		NECD			ES, RDC, NICMS		FFIS, Glastir, RDC, FMP				FAS, FC, WFR
Air quality		EPA, CAA, NECD			NICMS						
Resilience to natural disaster	flooding				ES, Glastir	EWGS, Glastir, RDC, WGS					FC
	fire			CC							

Notes to Table 8:

Acts/programmes listed in the following order: England, Wales, Scotland and Northern Ireland.
Acronyms: CAA – Clean Air Act, CAFRE – College of Agriculture Food and Rural Enterprise, CC – Cross Compliance, CROW – Countryside and Rights of Way Act, ECSFDI – England Catchment Sensitive Farming Delivery Initiative, ES – Environmental Stewardship, EWGS – England Woodland Grant Scheme, FAS – Farming Advice Service, FATI/ETIP – Farm Advice Training and Information / ELS (Entry Level Stewardship) Training and Information Programme, FC – Farming Connect, FFIS – Farming and Forestry Improvement Scheme, FMP – Farm Modernisation Programme, HD – (EC) Habitats Directive, IPPCD – (EC) Integrated Pollution Prevention and Control Directive, ND – (EC) Nitrates Directive, NECD – (EC) National Emission Ceiling Directive, NICMS – Northern Ireland Countryside Management Scheme, RDC – Rural Development Contracts, WBD – (EC) Wild Birds Directive, WCA – Wildlife and Countryside Act, WFD – (EC) Water Framework Directive, WFR – Whole Farm Review, WGS – Woodland Grant Scheme, WRA – Water Resources Act.

Source: Matrix format is developed based on Ribaudo, M., L. Hansen, D. Hellerstein and C. Greene (2008), *The Use of Markets to Increase Private Investment in Environmental Stewardship*, United States Department of Agriculture, Economic Research Service, Economic Research Report Number 64, Washington D.C. and OECD (2010c), "Policy Measures Addressing Agrienvironmental Issues", *OECD Food, Agriculture and Fisheries Papers*, No. 24, OECD Publishing, Paris..

7. Conclusion

This study reviews policy measures for providing agri-environmental public goods in the United Kingdom. It is one of the first studies to try to synthesise a broad range of agri-environmental policies and agri-environmental public goods in the United Kingdom.

United Kingdom agri-environmental policies target nine agri-environmental public goods i.e. agricultural landscapes, biodiversity, water quality, water quantity, soil quality, climate change – carbon storage, climate change – greenhouse gas emissions, air quality, resilience to natural disaster (flooding and fire).

Most agri-environmental public goods are jointly produced with agricultural and food production activities in the United Kingdom. The greatest range and quantity of agri-environmental public goods is associated with extensive grazing livestock farms and extensive mixed farms in both lowland and upland areas. This type of farming is closely associated with High Nature Value farming. Arable cropping and intensive grazing livestock farms deliver more limited, but nonetheless important agri-environment public goods. The provision of agri-environmental public goods has been enhanced through increasing coverage and changes to agri-environment schemes. Environmental costs remain however and are particularly associated with intensive cropping and livestock systems. Some agri-environmental public goods are delivered through historic or cultural infrastructure and management practices which may no longer be directly linked to mainstream agriculture (e.g. hedges and walls). In order to secure an adequate amount of provision, policy measures have targeted the drivers influencing the provision of agri-environmental public goods, rather than the agri-environmental public goods themselves.

Limited proxy data suggests that there is strong demand for agri-environmental public goods in the United Kingdom, and based on the environment accounts for agriculture, a continuing need. There is however a mixed picture in terms of the supply of these goods, with some increasing, others decreasing and a number unclear. This could reflect the difficulty in reversing negative trends in biodiversity, for example, and the time required to achieve this, but it could also relate to an under-provision of certain public goods, potentially linked to the funding and delivery mechanisms available.

In order to achieve agri-environment priorities in the United Kingdom, there is a balance between regulation, much of which is drawn together and given added force by being included in cross compliance, and voluntary agri-environment scheme measures, together with technical assistance. While there is a broadly similar approach across the UK, there are differences in the detail of design and implementation at country level due to the devolved regional structure of government. The reform of the CAP will mean that the nature and balance of programmes will be altered for the period 2014-2020.

For some agri-environmental public goods (e.g. water quality), farmers are required to meet reference levels at their own costs via regulatory measures. Negative incentives (taxes or charges) are not used at present but, it is known that, in some cases, they can be good approaches to internalise negative externalities and improve the environment associated with agriculture. Some discussion on the potential use of a wider range of agri-environment policy measures to addressing environmental issues could be beneficial. In addition, policy measures targeting environmental outcomes (output-based policy measures) should be adopted to increase cost-effectiveness of agri-environmental policy measures. The co-ordination of different policy measures to secure the effective and efficient delivery of agri-environmental public goods could also usefully be discussed.

The costs associated with the provision of agri-environmental public goods also need to be kept under review. Not all agri-environmental public goods have clear reference levels and environmental targets, and even where they do, these are not presented and communicated clearly and coherently. While cross compliance conditions comprise the reference levels for most goods, the reference levels for the others are based on current farming practices implying that the government may need to make payments to achieve sustainable farming practices. There could be value in discussing and reviewing to what extent farmers should bear the costs and to what extent governments/ society should bear the costs. In addition, some agri-environmental public goods have use values which could be taken into account.

This study also identifies that there are some interesting approaches being undertaken by private companies in the form of Payment for Ecosystem Services schemes. The achievements of these schemes need to be monitored, and their wider potential assessed, in order to improve the cost-effectiveness of agri-environmental policies.

Annex Table 1. Reference levels and agri-environmental targets in the United Kingdom

1) Agricultural landscapes	
Environmental targets	No national targets. However, the UK is a signatory to the European Landscape Convention which provides a framework for landscape-focused activity. Landscape is a key objective of agri-environment schemes and integrated into priorities for agri-environment scheme targeting. Landscape Character Areas and Assessments are used to communicate landscape characteristics and priorities, and monitor progress (e.g. National Character Areas in England).
Reference level	GAECs covering hedges, walls, trees and other landscape features under cross compliance.
2) Biodiversity	
Environmental targets	The UK Post 2010 Biodiversity Framework supersedes the UK Biodiversity Action Plan. It sets out common purpose and shared priorities in pursuit of the Aichi targets. It seeks to co-ordinate activities and links to individual country biodiversity strategies (e.g. Northern Ireland Biodiversity Strategy) and the EU Biodiversity Strategy. One of the goals of the framework is to reduce the direct pressures on biodiversity and promote sustainable use, which includes agricultural land.
Reference level	GAECs covering special sites, environmental impact assessments, over/under grazing and burning, as well as SMRs covering wild birds and habitats (SMRs 1 and 5), all under cross compliance.
3) Water quality	
Environmental targets	The UK is implementing the EC Water Framework Directive (WFD) which seeks to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters (to one nautical mile) and groundwater. The overall aim is for the "water bodies" and "protected areas" within each River Basin District to achieve good ecological status by 2015. Reduction of diffuse water pollution from agriculture is key to meeting WFD targets in many catchments.
Reference level	GAECs covering soil protection, watercourse protection and no spread zones, as well as SMRs covering groundwater and nitrate vulnerable zones (SMRs2 and 4), all under cross compliance. This includes a maximum of 170 kg N/ha for livestock manure, although this is subject derogations, awarded on a country by country basis, to permit up to 250 kg N/ha in certain conditions.
4) Water quantity/ availability	
Environmental targets	No national targets. However, there is an EU target to promote the sustainable use of water and mitigate the effects of drought under the EC Water Framework Directive. There are also country-specific water strategies (e.g. Water Strategy for Wales).
Reference level	GAEC covering water abstraction under cross compliance. This links to farmer compliance with water abstraction licences granted under the Water Resources Act.
5) Soil quality and protection	
Environmental targets	No national targets. However, the EC Soil Thematic Strategy seeks to ensure the sustainable use of soils by preventing further degradation and restoring degraded soils. There are also country-specific soil strategies or frameworks for action with goals. For example, the Soil Strategy for England "Safeguarding our Soils" which includes a vision that "by 2030, all England's soils will be managed sustainably and degradation threats tackled successfully".
Reference level	GAECs covering soil protection, land not in agricultural production and over/under grazing, as well as SMRs covering ground water, sewage sludge and nitrates (SMR 2, 3 and 4), all under cross compliance.
6) Carbon storage	
Environmental targets	No national targets. However, the EC Soil Thematic Strategy seeks to ensure the sustainable use of soils and the Kyoto Protocol seeks to protect soils as carbon stores.
Reference level	No national baseline (Current farming practices are equal to reference levels)
7) Greenhouse gas emissions	
Environmental targets	25% reduction of greenhouse gas emissions from agriculture from 51 MtCO2e in 2010 to 38 MtCO2e in 2030 (Committee on Climate Change). The government is pursuing a voluntary approach, based on the provision of information and encouragement, and via Agriculture Industry GHG Action Plans.
Reference level	No national baseline (Current farming practices are equal to reference levels)
8) Air quality	
Environmental targets	EC National Emission Ceiling Directive and Gothenburg Protocol set national target for ammonia of 297 kilotonnes, to be achieved by 2010. This has been met. There is no new target but ammonia emissions being kept under review, see UK Air Quality Strategy.
Reference level	GAECs covering soil protection and burning, as well as SMRs covering sewage sludge and nitrate vulnerable zones (SMRs 3 and 4), all under cross compliance. Also Integrated Pollution Prevention and Control (IPPC) requirements for intensive industrial agricultural units (mainly pigs and poultry).
9) Resilience to flooding	
Environmental targets	No national targets. However, the EC Flood Directive seeks to reduce the probability of flooding and its potential consequences. There are also country-specific flood and coastal erosion risk management strategies (e.g. Scotland's National Flood Risk Assessment and Flood Risk Management Strategies and Local Flood Risk Management Plans)
Reference level	No national baseline (Current farming practices are equal to reference levels)
10) Resilience to fire	
Environmental targets	No national targets
Reference level	No national baseline (Current farming practices are equal to reference levels)

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