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Co-benefits for Water and Biodiversity from the Sustainable Management of High Nature Value Farmland

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by

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Executive Summary

Agriculture systems in Europe range from very intensive production on fertile land with high inputs to very extensive High Nature Value (HNV) farmland on marginal land with low inputs. HNV farmland comprises those areas of Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports, or is associated with, either a high level of species and habitat diversity, or the presence of species of European conservation concern, or both. A range of EU policies are targeted at HNV farmland and all EU Member States are required to identify, monitor and support the ecological and economic viability of HNV farmlands. Despite their important role in the delivery of ecosystem services, many of these areas are under threat from abandonment, intensification and land use change.

A broad range of landscape types in Ireland are represented in HNV farmland including extensively farmed uplands, areas of calcareous grassland and limestone pavement, machair/coastal grasslands, the drumlin belt from Clew Bay to Cavan with large areas of wet grasslands, the islands, river floodplains and the Wexford slobs. A national map of HNV farmland likelihood for Ireland at electoral division (ED) scale highlights the varied nature of the agricultural land base. The spatial coincidence of HNV farmland and rivers of good ecological status, and areas with high and very high HNV farmland likelihood, were compared with the distribution of river water bodies of good ecological status (2010–2012). Of the assessed river lengths, 63% of the river water bodies at good status and 79% of the river water bodies at high status occurred in areas with high HNV farmland potential.

Maintenance of high-status water bodies in these areas requires an integrated and targeted approach to the management of HNV farmland to meet the requirements of the Water Framework Directive. The management of HNV farmland for biodiversity has the potential to have co-benefits for water quality and quantity, such as the regulation of flooding and maintaining base flow. Improved co-ordination and spatial targeting of initiatives for HNV farmland could play a major role in meeting the requirements of the Water Framework Directive and the Birds and Habitats Directives.

The spatial heterogeneity in land capacity and the range of intensities of farming in Ireland highlights that approaches need to be locally adapted within a broader framework. There is a real need to expand the range of locally led integrated catchment/landscape management initiatives, which aim to simultaneously provide multiple ecosystem services. Initiatives must take a participatory and partnership approach that will encourage an innovative network of stakeholders working in partnership to develop locally adapted and results-orientated solutions. Furthermore, policy objectives for different land use types and the services required from the range of agricultural land use intensities in Ireland need to be clear. The complex policy demands, coupled with the heterogeneity of the land base, highlight the need for translation of clearer national policy into local initiatives.

1 Introduction

This report looks at the potential synergies between biodiversity and water quality delivery on High Nature Value (HNV) farmland. We describe HNV farmland in an Irish context and discuss the potential co-benefits of HNV farmland for biodiversity and water quality. The objectives of the study were to:

- explain the HNV farming concept;
- describe the distribution of HNV farmland in Ireland and explain the characteristics of HNV farmland in an Irish context;
- show the spatial distribution of HNV farmland in relation to high-status water bodies;
- discuss the support measures available for HNV farming and the potential for design of measures to provide both enhanced biodiversity and water quality in HNV areas.

2 Explaining the HNV Farmland Concept

2.1 What is HNV Farmland?

Farmland covers almost 50% of the land area in Europe (Eurostat, 2015a), with agriculture systems ranging from very intensive production on fertile land with high inputs to very extensive HNV farmland on marginal land with low inputs.[1] HNV farmland is important for the conservation of species and habitats that depend on low-intensity agricultural systems and for the maintenance of high biodiversity levels outside areas with nature conservation designations (Cooper *et al*. 2007). Many of these farms are in Areas of Natural Constraint (ANCs). These are often mountainous areas, or areas where natural constraints limit opportunities for intensification, and so land is prone to abandonment (Eurostat, 2013).

In Europe three broad types of HNV farmland have been described (Andersen *et al*., 2004).

Definition of HNV farmland

HNV farmland comprises those areas of Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports, or is associated with, either a high level of species and habitat diversity, or the presence of species of European conservation concern, or both (Andersen *et al*., 2004).

- **Type 1 HNV farmland** is farmland dominated by semi-natural vegetation.
- **Type 2 HNV farmland** is farmland dominated by low-intensity agriculture and a mosaic of semi-natural and cultivated land and small-scale features.
- **Type 3 HNV farmland** is farmland supporting rare species or a high proportion of European or world populations of species of conservation concern.

At the farm level, whole, partial and remnant HNV farmland have been described by Keenleyside *et al*. (2014). In whole farm HNV, the entire farm is a low-intensity system; partial HNV systems occur where there is low-intensity management of some land, alongside intensive practices on other land parcels; and remnant HNV farmland (which is no longer HNV farmland) describes farmland where there are features of high nature value, but its land management is irrelevant to the main farm business, which is based on intensive agricultural production with some abandonment or management for cross-compliance, nature conservation or agri-environment payments from the EU.

2.2 EU Policy Context

All EU Member States are required to identify, monitor and support the ecological and economic viability of HNV farmlands (EEA, 2004). HNV farmland produces many important environmental public goods, such as clean air, clean water, a stable climate, agricultural biodiversity and aesthetic landscapes (Cooper *et al*., 2009; Lefebvre *et al*., 2012). As a result of their important role in the delivery of ecosystem services, the identification, monitoring and support of HNV farmland has been a policy requirement for EU countries since 2003 (Beaufoy *et al*., 2010) as many of these areas are under threat from abandonment, afforestation and intensification (Keenleyside and Tucker, 2010; Terres *et al*., 2015). HNV farmland extent and quality was one of the original set of agri-environment indicators developed by the European Commission in the late 1990s and remains a key indicator in the Common Monitoring and Evaluation Framework (CMEF) guidelines for the Common Agricultural Policy (CAP) (DG Agriculture, 2006; Eurostat, 2015b). The European Agricultural Fund for Rural Development (EAFRD) established HNV farmland as a key priority of axis 2 for Rural Development Programmes from 2007 to 2013 (CEC, 2006; EC, 2013). The current rural development

1 Beaufoy, G., 2008. *HNV Farming – Explaining the Concept and Interpreting EU and National Policy Commitments*. Internal document, European Forum on Nature Conservation & Pastoralism, UK Report, unpublished.

regulations of the CAP (2014–2020) further solidify the important role of HNV farmland, where they include the restoration and preservation of biodiversity in HNV farmland within one of the six EU priorities for rural development [Council Regulation (EC) No 1305/2013].

HNV farmland straddles both agricultural and biodiversity policies in Europe. The EU Biodiversity Strategy aims to halt the loss of biodiversity and ecosystem services by 2020, and target 3 of the strategy specifically aims to show measureable improvement in the provision of ecosystem services and conservation of species and habitats depending on, or affected by, agriculture and forestry (EC, 2011a,b). In the 2015 Commission assessment of progress in implementing the EU Biodiversity Strategy, HNV farmland and organic farming were highlighted as examples of EU farming systems that contribute to maximising the agricultural area covered by biodiversity measures while providing socio-economic benefits (EC, 2015a). The assessment highlighted that the overall trends continue to be a cause for serious concern, but that there are many local improvements as a direct result of good agricultural practices and biodiversity measures under the CAP; the report cited in particular agri-environment measures and measures for Natura 2000 sites. It stated that these examples carry an important message on the achievability of the 2020 biodiversity target, but they need to be spread wider to achieve measurable results at the EU level (EC, 2015b). In order to achieve the goals of the biodiversity strategy, the assessment highlighted the role of the integration of biodiversity targets into Member State CAP Rural Development Programmes and also noted the benefits of biodiversity for improving water management (EC, 2015a).

2.3 HNV Farmland in Ireland

A broad range of landscape types in Ireland are represented in HNV farmland. One such important landscape class is upland areas, dominated by semi-natural vegetation such as blanket bog, wet heath and acid grassland (commonage is a major component of farming systems in these regions). It is important to note that “upland-type” semi-natural vegetation (dry and wet heaths, blanket bog, grasslands dominated by *Molinia*, *Nardus* and *Festuca/Agrostis*, acid grasslands) extends to sea level in western Ireland due to the wet climate. Other key HNV farmland landscape types include areas of calcareous grassland and limestone pavement, machair/coastal grasslands, the drumlin belt from Clew Bay to Cavan with large areas of wet grasslands, the islands, river floodplains and the Wexford slobs.[2]

Since the early 2000s, there have been a number of initiatives on HNV farmland in Ireland (Figure 2.1). These started with the 7th European Forum on Nature Conservation and Pastoralism (EFNCP) conference in Ennistymon, County Clare, entitled “Recognising European pastoral farming systems and understanding their ecology: a necessity for appropriate conservation and rural development policy”. Following this, work commissioned by the Heritage Council highlighted the need for HNV farmland in Ireland to be defined,

2 Area of land that was reclaimed from the River Slaney estuary and is protected by dikes.

Figure 2.1. Timeline 2000–2016 HNV farmland concept and Ireland

delimited and targeted for support (Jones *et al.*, 2003). This coincided with the instigation of the BurrenLIFE project, a 5-year EU LIFE Nature project focusing on a HNV farmland landscape in County Clare (Dunford *et al.*, 2010). A PhD project examining the nature value of farmland in areas outside designated areas in east Galway (Sullivan, 2010) and two PhD projects examining the nature value of farmland in the north-west of Ireland (Boyle, 2015; Hayes, 2015) were carried out. The Heritage Council provided funding to the EFNCP to undertake work on HNV farmland; a number of reports have arisen from this work (McGurn, 2010, 2011; McGurn and Moran, 2010). Currently, the Institute of Technology, Sligo, is one of 13 EU participants in a recently funded Horizon 2020 network project, called HNV Learning, Innovation and Knowledge (Link), which began in April 2016. The HNV Link project aims to develop a network dedicated to supporting HNV farmland, focusing on innovations that simultaneously improve "socio-economic viability" and "environmental efficiency" (see www.hnvlink.eu). The IDEAL-HNV project, which began in 2013, was the first Irish national-scale project set out to identify the distribution and extent of HNV farmland throughout the country. Alongside these projects, HNV farmland was incorporated as a specific target in Ireland's Rural Development Programme (RDP) 2006–2013, under axis 2. Support was mainly targeted at agri-environment action-based measures for commonages and Natura 2000 areas.

Furthermore the need to develop criteria to identify HNV farmland and measures to address threats was highlighted under target 5 of Ireland's Biodiversity Action Plan for 2011–2016 (DAHG, 2010), which aimed to optimise the use of opportunities under agriculture, rural development and forest policy to benefit biodiversity.

Official reporting to the EU on the total area of HNV farmland in Ireland still uses the EEA/JRC figure of 1.1 million ha (Paracchini *et al.*, 2008), generally thought to represent farmland areas dominated by Natura 2000 and commonage areas, which impacts on the policy supports for these areas as identified above. The IDEAL-HNV project produced a national map of HNV farmland likelihood for Ireland (Matin *et al.*, 2016). Using five variables available at a national scale, a map of HNV farmland likelihood was created at a tetrad (2 × 2 km) scale, and was then scaled up to electoral division scale. The variables used were:

1. CORINE[3] land cover data split into five classes and scaled 1–5 as a representation of farmed semi-natural vegetation; resultant classes were arable and permanent crops, shrub, pasture, unfarmed and farmed semi-natural land (water, forest, rock, and built areas excluded in analysis);
2. average stocking density;
3. hedgerow density;
4. river and stream density;
5. soil diversity.

Variables 1 and 2 were given greater weight, as they are considered more influential in the identification of HNV farmland than the remaining variables. This decision was based on existing research (Sullivan, 2010; Boyle, 2015) and expert opinion. The map represents only HNV farmland potential and must be interpreted within the limitations of the data used to produce it (see Figure 2.2). The colour assigned to the grid indicates the likelihood of finding HNV farms in this area. However, regardless of the colour assigned to an area, there may be a range of farms, from intensively to extensively managed, within the region.

Research into the types of HNV farmland in Ireland identified six distinct types (Sullivan *et al.*, forthcoming). This research also considered the links between the Irish types of HNV farmland and the existing HNV farmland typologies described in Europe (see Figure 2.3). The six types described were:

1. *Whole HNV farmland with no commonage*. The majority of farms in this subtype occurred in the Burren, although coastal farms with high proportions of sand dunes or machair would also be included in this category. Most of these farms had high proportions of dry, semi-natural grasslands and low stocking densities. Semi-natural habitat cover was very high (~75%), stocking density was low (~0.6 LU/UAA, livestock units per hectare of utilisable agricultural area) and field boundary density was often low (~100 m/ha).
2. *Small whole HNV farmland*. These farms had very high cover of semi-natural habitats (both

3 Co-ORdinated INformation on the Environment (CORINE) is a standardised data series compiled by the EU.

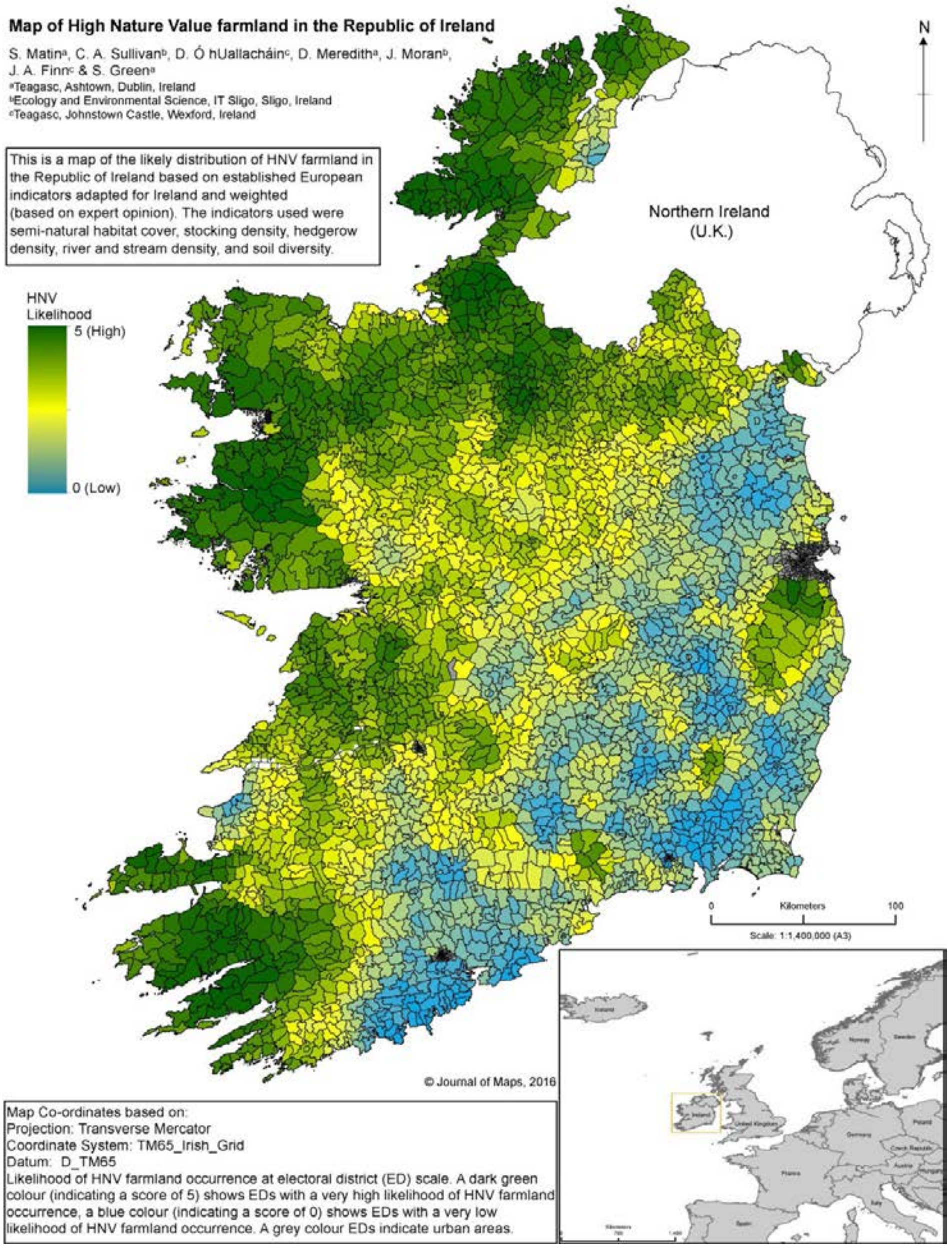


Figure 2.2. HNV farmland likelihood on an electoral division (ED) scale. From Matin *et al.* (2016). Green shades indicate high likelihood of having HNV farmland, yellow indicates intermediate likelihood of having HNV farmland and blue shades indicate low likelihood of having HNV farmland.

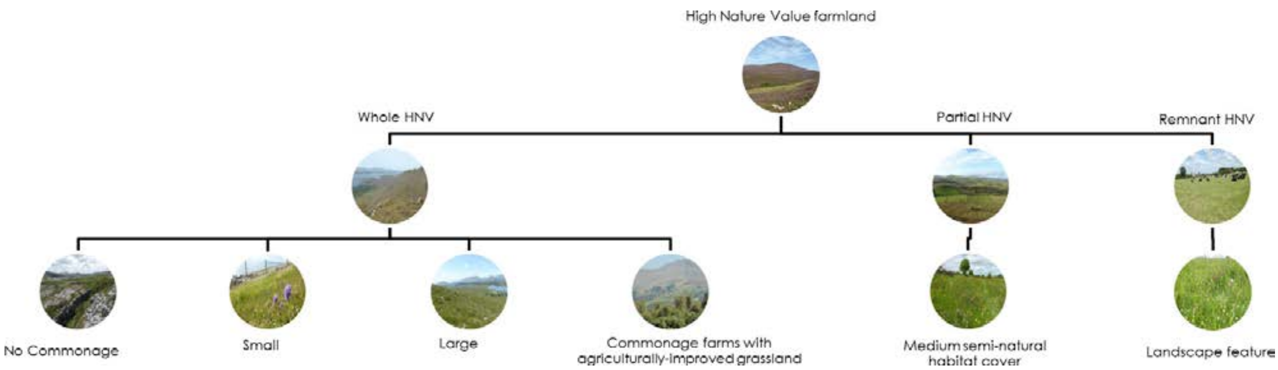


Figure 2.3. The types of HNV farmland in Ireland (based on research carried out for the IDEAL-HNV project).

grasslands and peatlands). Many of these farms also included shares in commonage. These farms were all small and included all the island farms. Semi-natural habitat cover was very high (~80%), stocking density was low (~0.50 LU/UAA) and field boundary density was very high (~300 m/ha).

3. *Large whole HNV farmland.* These farms were all quite large (> 100 ha) and had very high semi-natural habitat cover. Peatlands were very common on these farms and many of them had shares in commonage. The stocking density was very low on these farms, as was the field boundary density (which is not unusual for farms with high peatland cover). Semi-natural habitat cover was very high (~90%), stocking density was very low (~0.30 LU/UAA) and field boundary density was low (~90 m/ha).

4. *Whole HNV commonage farmland with agriculturally improved grassland*. This category was similar to the other whole HNV subtypes described here, but these farms had lower proportions of semi-natural habitats. The majority of these farms also had shares in commonage. Unlike many of the other types described here, they had higher cover of improved agricultural grassland and slightly higher stocking densities. Semi-natural habitat cover was high (~70%), stocking density was low (~0.70 LU/UAA) and field boundary density was medium (~185 m/ha).

5. *Partial HNV farmland*. Partial HNV farmland has a high cover of semi-natural habitats (such as wet grassland or peatland) but, unlike whole HNV farmland, can also have a significant cover of improved agricultural grassland. Farmland in this category also often has semi-improved grassland (fields that have been fertilised or drained in the past but are now rush dominated and prone to poaching). This type of farmland occurs where there is a mixture of grassland intensities in a landscape such as in County Leitrim, east Mayo and east Galway. Semi-natural habitat cover was medium (~55%), stocking density was low (~0.70 LU/UAA) and field boundary density was high (~210 m/ha).

6. *Aggregate HNV farmland*. This type of farmland was found in the Shannon Callows. Each individual farm had a lower proportion of semi-natural habitat cover than whole or partial HNV farmland, but these smaller proportions made up part of the whole floodplain, which is nationally very important for wet grassland, hay meadows and wading bird breeding. Semi-natural habitat cover was low to medium, stocking density was medium and field boundary density was medium.

This research was not a comprehensive inventory of all types of HNV farmland in Ireland but aimed to cover the main types that occur. Type 2 HNV farmland (section 2.1) in particular was not evident from the IDEAL-HNV fieldwork but may occur where extensive organic systems are in place and is not included in the six types described above. Type 3 HNV farmland would also be overlooked by fieldwork, as it relates to populations of species that are nationally or internationally important but would preferentially select more intensively farmed land. Areas used by overwintering geese and swans are a good example of type 3 HNV farmland in Ireland; this HNV farmland is quite easily identified using National Parks and Wildlife Service species distribution data.

Ireland as a whole appears to have a good mix of semi-natural vegetation and more intensive food production areas, resulting in a good national balance between provisioning and regulatory ecosystem services. This was highlighted in a 2015 EU study on the links between ecosystem service supply and semi-natural vegetation in agricultural land in Europe (García-Feced *et al*., 2015). However, this masks regional differences within Ireland as evident in the HNV map (Figure 2.2) and overlooks serious threats to HNV farmland and resultant knock-on consequences for ecosystem service supply. Threats to HNV farmland include:

- land abandonment;
- land use change such as afforestation (note that semi-natural woodland and woody vegetation are an important component of HNV farmland landscapes but change of land use from semi-natural vegetation to monoculture coniferous plantations has consequences for biodiversity);
- farm intensification and polarisation (both intensification and abandonment in different areas of one farm).

In essence, the picture of sustainable resource management and ecosystem service supply is very different when viewed on different scales, from country to region to farm level. In particular, the risk of land abandonment in the Border, Midlands and West regions of Ireland is classified as one of the highest in the EU due to low farm incomes, remoteness, low population densities and ageing farmer populations (Terres *et al*., 2015). Much of this stems from the inadequate support for HNV farmland, and, in particular, the fact that regulatory ecosystem services are not rewarded by the market, putting HNV farmland at a further disadvantage to conventional intensive farm and forestry land use.

Ireland's RDP 2014–2020 identifies that the HNV concept is still not fully established in Ireland (DAFM, 2015). HNV farmland was included under priority 4 of the new RDP programming structure, which aims to restore, preserve and enhance ecosystems related to agriculture and forestry, with a particular focus on the following areas: (a) biodiversity, including Natura 2000 sites and areas facing natural constraints, HNV farmland and the state of European landscapes; (b) water management; and (c) soil management (EC, 2013). Measures included in the €4 billion RDP 2014–2020 are outlined in Figure 2.4. While none of these are solely targeted at restoring, preserving or enhancing HNV farmland, the measures relating to agri-environment and climate and ANCs would be of particular relevance. Ireland's locally led agri-environment schemes (LLAES) proposal in the current RDP (2014–2020) has significant potential to bring innovative solutions to bear to ensure sustainable land management. It was specifically targeted at meeting the requirements of the EU Birds (2009/147/EC), Habitats (92/43/EEC) and Water Framework (2000/60/EC) Directives, and has a total budget over the programme period of €70 million; many of the priority areas identified for the implementation of this proposal would be considered HNV farmland areas.

The LLAES measures included in the RDP were designed to complement the national Green Low-Carbon Agri-environment Scheme (GLAS).

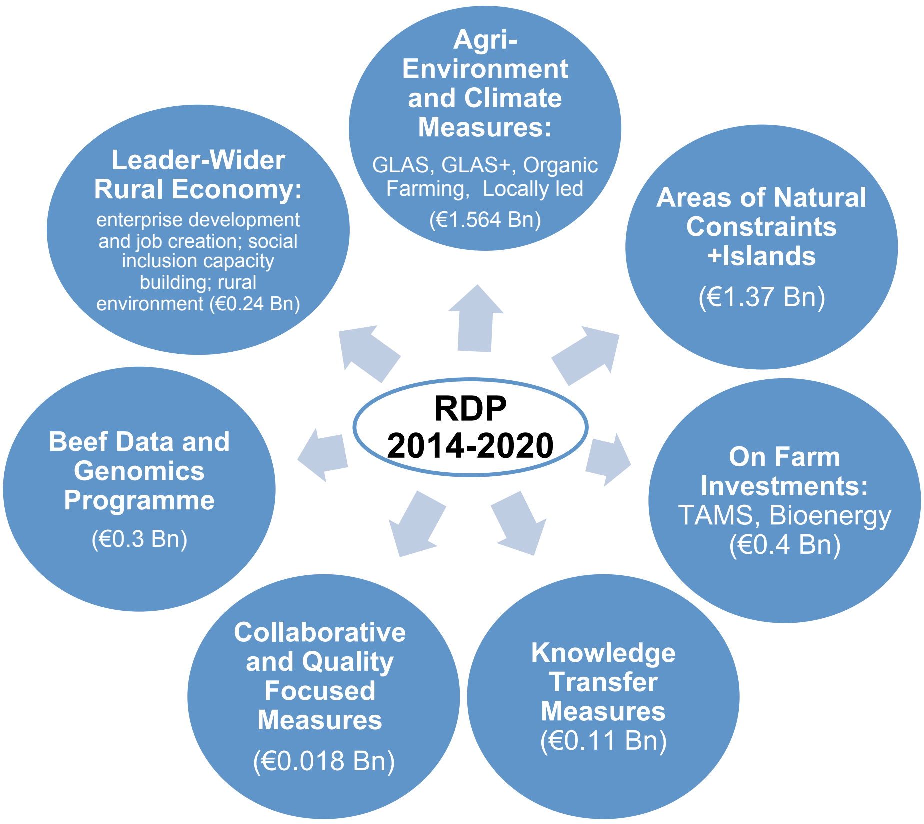


Figure 2.4. List of measures included in Ireland's RDP 2014–2020. GLAS, Green, Low-Carbon, Agri-Environment Scheme; TAMS, Targeted Agricultural Modernisation Schemes.

GLAS is a traditional action-based approach that pays farmers to undertake particular actions that are linked to cross-cutting objectives of climate change, water quality and biodiversity. The LLAES aim to address specific environmental and biodiversity challenges not addressed at the national level through GLAS. It is envisaged that this will include both schemes addressing centrally identified priorities and an open competitive call. All priorities will be linked to implementation of the EU Birds, Habitats and Water Framework Directives. The centrally identified priorities include the continuation and expansion of the Burren programme;[4] priority freshwater pearl mussel catchments; and hen harrier areas. LLAES aim to encourage locally derived solutions and will require submission of proposals by local groups. The only theme currently identified for the competitive call in the RDP is the conservation/restoration of upland peatlands. At the moment it looks like, as a minimum, there will be LLAES developed for the Burren, freshwater pearl mussel catchments, hen harrier areas and upland peatlands.

4 The previous programme is known as the BurrenLIFE project (2005–2010).

3 Water Quality and HNV Farmland

3.1 Water Quality and Agriculture

Agriculture has a significant impact on water quality (Harding *et al*., 1999; Moss, 2008; OECD, 2012); the intensity of agriculture in turn has a major influence on this impact. Catchments that are close to pristine conditions, i.e. dominated by natural or semi-natural vegetation, put less pressure on water quality than areas that are more intensively farmed (Harding *et al*., 1999; Moss, 2008). However, it must be noted that the relationship between intensity of land use and impact are not straightforward (Doody *et al*., 2012). Several decades of research into the relationship between agriculture, water quality and quantity within catchments has influenced policy. This has led to greater understanding of the driving forces–pressures–state–impact–response (DPSIR) pathways; and the establishment of the catchment/watershed, as the unit of management and evaluation of local, regional, national and international water policies (Jordan *et al*., 2012). The focus of water monitoring and management is often on the larger downstream channels of rivers, but the health of these larger downstream channels is dependent on maintaining good or high ecological status in headwater streams (McGarrigle, 2014). First- and second-order streams cover 77% of the river channel network in Ireland and, of those monitored, 30% failed to meet good ecological status, highlighting the need for an integrated catchment management approach (McGarrigle, 2014). The need for a more integrated approach is further emphasised by the persistent pressure from diffuse agricultural pollution and the limited success in addressing the decline in ecological status of rivers across Europe (OECD, 2012). Balancing the management of landscapes dominated by agriculture to achieve profitable agriculture while ensuring the sustainability of water resources and enhancing biodiversity is a major challenge and raises multiple "resource dilemmas" (Jordan *et al*., 2012). The heterogeneity of land capacities for production, susceptibility to pollution and ecological sensitivity requires a targeted, risk-based and integrated approach to protect sensitive areas while maintaining/enhancing food production (McGonigle *et al*., 2012), which is of particular importance in an Irish context given the varied nature of the agricultural land base, as emphasised by the map of HNV farmland likelihood produced by the IDEAL-HNV project (see Figure 2.2). Water quality and food production goals need to be cognisant of, and set in the wider context of, the general need for a more integrated approach to natural resource management in agricultural landscapes (Bathgate *et al*., 2009).

3.2 Watercourses and Farmland

Watercourses (i.e. rivers, streams and drainage ditches) are an important component of Irish farmland. There are very few farms in Ireland that do not have some linear water feature as a component of their field boundaries (with the exception of some farms over karst limestone areas). Drainage ditches are common in intensively farmed reclaimed land areas. While drainage ditches and streams are common in areas with poorly draining soils, they can also be present in conjunction with other field boundary types, such as hedgerows or earth banks (Table 3.1). In the south- and mid-east of Ireland (Counties Cork, Waterford, Kilkenny, Carlow, Wexford, Wicklow and Meath) 48% of 294 km of field boundaries recorded on 50 farms were defined as watercourses (Sheridan *et al*., 2011). In east Galway drainage ditches, streams and rivers made up at least 18% of 286 km of field boundaries surveyed on 32 farms (Sullivan *et al*., 2013). And in north-western Ireland (Mayo, Sligo and Leitrim) drainage ditches, streams and rivers comprised 15% of 461 km of field boundaries on 60 farms (Boyle, 2015).

Drainage ditches and streams were very common components of field boundaries on the farms surveyed for the IDEAL-HNV project. Drainage ditches and streams, together with features that contained some portion that was water, made up 18% of 882 km of field boundaries surveyed on 102 farms in Counties Leitrim, Cork, Clare, Galway, Westmeath, Offaly, Mayo, Wicklow, Donegal and Waterford (Table 3.1). Management of this extensive network of watercourses on Irish farmland is key to management of water resources in Irish farmland.

Table 3.1. Field boundary type and length on IDEAL-HNV farms surveyed in 2013 and 2014. Those that contained drainage ditches or streams are in bold

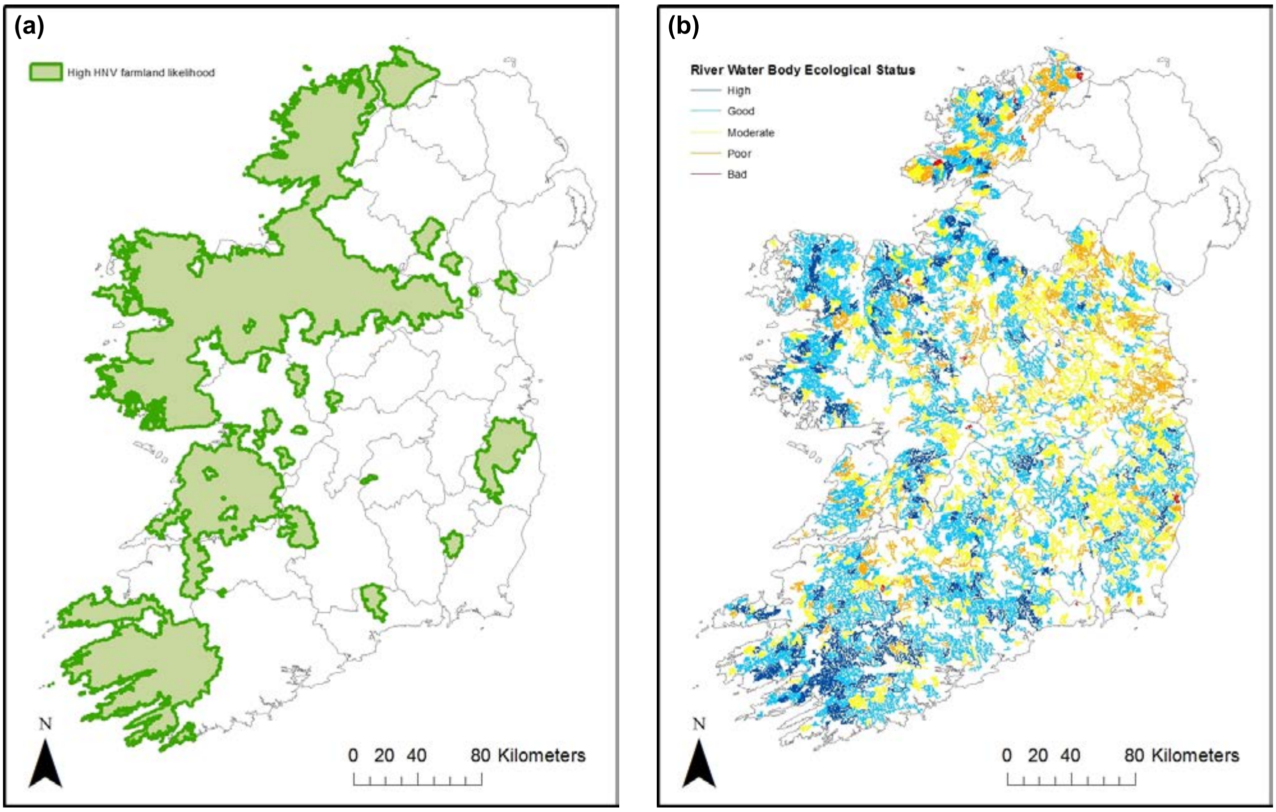
Field boundary type	Length (km)	Proportion of total field boundaries (%)
SW	251.99	28.55
H	157.28	17.82
DD	89.12	**10.10**
EB	73.76	8.36
TL	73.66	8.34
HEB	56.58	6.41
HSW	40.79	4.62
HDD	26.42	**2.99**
SWEB	26.24	2.97
DDTL	22.59	**2.56**
EBDD	18.84	**2.13**
EBTL	14.95	1.69
SWTL	14.27	1.62
HTL	13.44	1.52
SWDD	2.81	**0.32**
Total	882.73	100.00
Total proportion of field boundaries that contained some portion that was a water course (%)		**18.1**

EB, earth bank; DD, drainage ditch or stream; H, hedgerow; SW, stonewall; TL, treeline.

3.3 Water Resources and HNV Farmland

Most HNV farmland is dominated by semi-natural vegetation, and the intensity of agriculture in these areas is low. HNV farmland predominantly occurs in the west of the country and in upland areas in the east (Figure 2.2). On a national level, water quality also varies across the country. For example, the nitrates levels at 180 river sites in 2008 showed average levels in the south-east to be generally much higher than those in the west (EPA, 2009). In order to compare the coincidence of HNV farmland areas with the distribution of good-status water bodies in Ireland using the ArcGIS geographic information system, the EDs with high and very high HNV farmland likelihood were extracted from the HNV farmland likelihood map (Figure 2.2) and merged to give one polygon. This polygon was overlaid on the river water bodies ecological status layer from the EPA geoportal (EPA, 2009; data available at http://gis.epa.ie). The intersecting area was extracted and the proportion of good-status water bodies within HNV farmland areas was calculated based on the total good-status water bodies in Ireland. Over half (53%) of the good-status water bodies in Ireland (EPA 2007–2009 data; available at http://gis.epa.ie) occurred in areas with high HNV farmland potential. Given that the HNV farmland potential area is 40% of the land mass of Ireland (Figure 3.1a), it is likely that HNV farming practices are not impacting water quality to the same extent as conventional farming, although further research would be necessary to verify this. This assertion is supported when the river bodies whose ecological status has been assessed by the Environmental Protection Agency (EPA) are considered. The most recent data (2010–2012) show that, of the assessed river lengths, 63% of the good-status river water bodies and 79% of the high-status river water bodies occurred in areas with high HNV farmland potential (Table 3.2).

Maintenance of high-status water bodies in these areas requires an integrated and targeted approach to the management of HNV farmland to meet the requirements of the Water Framework Directive. The decline in high-status water bodies in Ireland is a key concern highlighted by the EPA (White *et al*., 2014).



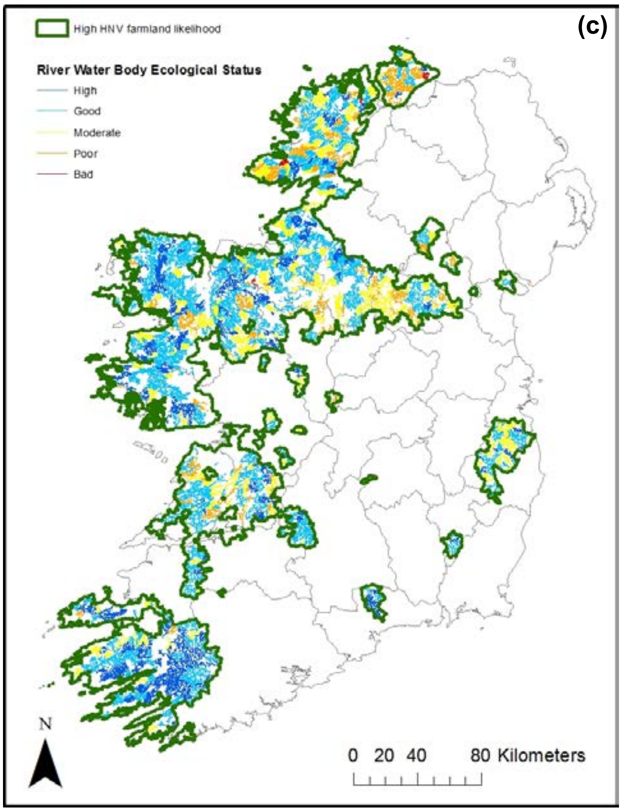


Figure 3.1. Spatial coincidence between HNV farmland and ecological status of river water bodies. (a) High potential HNV farmland areas (scaled up to ED scale and merged); (b) river water body ecological status 2010–2012; and (c) high potential HNV farmland areas only with river water body ecological status.

Many of these are located in upper parts of larger catchments and made up of lower order streams and, as highlighted above, the catchments are dominated by HNV farmland. Relatively low-intensity activities are important for their maintenance and major threats include drainage, fertilisation, one-off housing, forestry and wind farm developments, and animal access to water (White *et al*., 2014). The sensitive nature of these catchments and the need for management of HNV farmland to be cognisant of water resource issues are highlighted by the fact that very low-level changes can impact negatively on sensitive high-status waters. Given that additional measures may be required to reduce the impacts of farming and forestry in these sensitive catchments (White *et al*., 2014) there is a clear need to differentiate between the potential impacts of different types of farming and their spatial distribution within the catchment. In particular, support of extensive farming practices will be key in sensitive areas identified as potential risks for nutrient export to sensitive water bodies. White *et al*., (2014) noted that, nationally, 689 river water bodies (15%), 320 lake water bodies (39%), 15 transitional

Table 3.2. River bodies whose ecological status has been assessed, the length of the river body associated with the assigned status and the proportion of that river length in areas with high HNV farmland potential

River body status	Total length in Ireland (km)	Length in HNV farmland areas (km)	Proportion of total length in Ireland in HNV farmland areas (%)
Bad	185.55	108.22	58.33
Poor	7399.52	3990.81	53.93
Moderate	13,213.16	6220.18	47.08
Good	26,622.34	16,742.30	62.89
High	9288.32	7321.74	78.83
Total	56,708.89	34,383.25	60.63

(estuarine) water bodies (8%) and 29 coastal water bodies (27%) were classified as high status by the EPA based on Water Framework Directive data from 2007–2009. It was further noted that high-status catchments have little or no capacity for further intensification and need farm-specific management to maintain high-status sites (White *et al*., 2014).

The relationship between water quality and agricultural practices in HNV farmland areas is further emphasised in the work carried out on the Lough Melvin catchment. This area is dominated by HNV farmland and highlights that particular issues can still arise in catchments dominated by HNV farmland related to sedimentation and phosphorous loads. Multiple EU and national water protection strategies have failed to prevent the decline in water quality in the Lough Melvin catchment where agriculture is extensive but is estimated to contribute 62% of the phosphorous load to the lake (Doody *et al*., 2012). The work highlighted that an appropriate catchment-specific approach to the Water Framework Directive is essential. Specifically, individual fields within a HNV landscape can still be quite intensively managed resulting in build-up of soil phosphorus on improved agricultural grassland areas of catchment. HNV areas need as much expertise in "precision" nutrient management as intensively farmed areas. The Lough Melvin study showed that there is high connectivity to water bodies in HNV farmland areas. High stream density, poorly drained gley soils and a high density of artificial field drains introduced following grant aid in the 1970s means that there is medium to high risk to water quality at Lough Melvin (Doody *et al*., 2012). This high connectivity is similar to the other HNV farmland areas (see section 3.1). There is a clear need for integrated strategies that are adapted to the range of farmland types in Ireland, from HNV farms through to medium- and low-nature value (intensive) farms.

Research from the BurrenLIFE project in a very different catchment, dominated by karst limestone, highlighted the risks to water quality in HNV farmland areas despite the general low intensity of the agricultural practices. A risk of nutrient export model was developed as part of the BurrenLIFE project.[5] This evaluated the "pressure strength" posed by agricultural activity and tested a framework for classifying risk of nutrient export at the field level. Comparison of different farming systems in terms of their risk of nutrient transfer enabled the assessment of the potential of proposed changes to existing farming systems under BurrenLIFE to lower the risk of nutrient export to water. Results highlighted the potential of the BurrenLIFE farming project as a conservation model to reduce the risk of nutrient transfer to water. The BurrenLIFE programme is currently being rolled out as part of the LLAES under Ireland's RDP 2014–2020. Its specific objectives are to ensure the sustainable agricultural management of HNV farmland; to contribute to the positive management of landscape and cultural heritage; and to contribute to improvements in water quality and water usage efficiency in the Burren region (see www.burrenprogramme.com). This work highlights that solutions can be found and implemented where an integrated approach to natural resource management is locally adapted and results orientated.

5 Bartley, P., Moran, J. and Kuczynska, A., 2009. *Risk of Nutrient Export Model*. Unpublished final report commissioned by BurrenLIFE Project – Farming for Conservation in the Burren.

4 HNV Farmland's Potential for Delivery of Multiple Ecosystem Services

Trade-offs and synergies between agroecosystem services are a fundamental issue for the management of natural resources. Farming systems differ widely in terms of the use of resources, degree of intensification, species and orientation of production, local/regional socio-economic and market context, cultural roles, etc., and differentiation between livestock farming systems is required in an analysis of sustainability (Bernués *et al*., 2011). Depending on the environmental setting, the supply of multiple ecosystem services can arise from deliberate management of homogeneous landscapes/catchments or from inherent spatial heterogeneity in the landscape, but in either case the management of ecosystem services and biodiversity should be implemented as bundles rather than as individual targets (Crouzat *et al*., 2015). Linking biodiversity- and water-related ecosystem services (water quality and quantity) is challenging, as pressures on river ecosystem services will grow as land use intensifies, water demands increase and climate change accelerates over the coming decades (Durance *et al*., 2016). Strong "co–production" partnerships with a broad range of stakeholders need to be developed and nurtured to effectively deliver a range of ecosystem services (Durance *et al*., 2016). Co-ordinated approaches and appropriate management at multiple scales is required to provide multiple benefits, both for biodiversity- and wider water-related ecosystem services (Rhymer *et al*., 2010), and needs to be implemented through an integrated catchment/landscape management approach. It is also essential to recognise the inherent trade-offs and synergies between different ecosystem services (Power, 2010) from the outset.

4.1 Potential for Biodiversity and Water Services Delivery from HNV Farmland

The co-benefits associated with biodiversity and water quality have been noted across a number of studies, with a range of targets from riparian margins to lowland farmland birds to invertebrates (Bradbury and Kirby, 2006; Bradbury *et al*., 2010; Cole *et al*., 2012; Christen and Dalgaard, 2013; Delattre *et al*., 2013). In order to halt biodiversity decline, existing biodiversity areas needed to be supplemented with additional areas. Areas currently managed for water provision have potential to accrue additional benefits to biodiversity and vice versa (Chan *et al*., 2006). In terms of water regulation, catchment-scale flood risk management is currently popular among policymakers (Kenyon *et al*., 2008; Rouillard *et al*., 2015) and has the potential to simultaneously improve water quality, increase biodiversity and reduce flood risk. The Water Framework Directive river basin management plans, CAP cross-compliance and new agri-environment and climate strategies have been suggested as means of promoting co-benefits in flood risk management (Rouillard *et al*., 2015). Studies on catchments dominated by peatlands provide examples of what is possible in this regard. Damaged peatlands can negatively affect delivery of water-related ecosystem services, and there is evidence for rapid ecological responses in aquatic ecosystems to peatland restoration, related to reduced suspended solid loads and further deterioration in water quality (Martin-Ortega *et al*., 2014). Studies in the Exmoor area of the UK have shown the long-term benefit of peatland restoration for a range of ecosystem services, such as a reduction in carbon losses and improvement of water provision. These benefits can be offset against the costs of restoration in the long-term (Grand-Clement *et al*., 2013). Restoration of Exmoor peatlands resulted in one-third less water leaving the moorland during heavy rainfall over a 3-year period (see http://www.upstreamthinking.org/index.cfm?articleid=10828). This is particularly relevant in the context of Ireland, given the increased rainfall and flood events seen in recent years. Other test catchments in the UK – Eden, Wensum and Avon catchments – also hope that the mitigation features put in place will have multiple benefits for pollution retention, flooding, carbon sequestration, habitat creation and biodiversity (Owen *et al*., 2012). The Eden catchment is an upland catchment (www.edendtc.org.uk) with a range of farming intensities; some areas within the catchment would be considered

HNV farmland. Key diffuse pollution pressures identified here include fine sediment and phosphorus. The Exmoor partnership (between South West Water, the Devon Wildlife Trust, the Cornwall Wildlife Trust, the West Country Rivers Trust and the Exmoor National Park Authority) has led to the development of the upstream thinking initiative, which combines local farmers' and partners' knowledge to improve water quality at source. The initiative is targeted at moorland and semi-natural vegetation (i.e. HNV farmland) and has shown proven benefits for water quality and regulation (see http://www.upstreamthinking.org/index.cfm?articleid=8692). Researchers on the Working Wetlands project in central Devon (see http://www.exmoormires.org.uk/index.cfm?articleid=8691) have also shown how areas maintained for biodiversity (Culm grasslands – unimproved wet grasslands dominated by *Molinia caerulea* and rush pasture) have benefits for water regulation. It was highlighted that 11 times more water leaves intensively managed grasslands than Culm grasslands during storms. Many HNV landscapes in Ireland are dominated by wet grasslands and peatlands and could have the potential to deliver the same degree of ecosystem services in terms of water regulation and water quality.

The delivery of improved water quality and other water-related ecosystem services, while maximising the synergistic effects with biodiversity, requires the development of programmes that are locally targeted and results orientated. In the Irish context the new LLAES measure designed to complement national agri-environment measures such as GLAS and GLAS+ (DAFM, 2015) may be the vehicle to pilot such measures, particularly on upland peatlands dominated by HNV farmland. It is envisaged that LLAES will encourage the development of bespoke projects to meet specific environmental challenges at a local level. However, it must be noted that agri-environmental measures differ in their capacity to simultaneously provide multiple ecosystem services and can be hampered by individual administrations predominantly focused on a single environmental objective (Galler *et al*., 2015). Developing integrated multifunctional measures may also be hampered by a lack of knowledge of management effects on different ecosystem services, and a spatially targeted allocation of agri-environmental measures is necessary (Galler *et al*., 2015) to maximise the resources in areas where provision of multiple ecosystem services is possible. Galler *et al*. (2015) also note that although the EU directives emphasise potential synergies with other environmental objectives (for example, the EU Water Framework Directive refers to Natura 2000 and the Habitats Directive), implementation concepts and measures are not well co-ordinated between the individual regional administrations and synergies and trade-offs between environmental objectives are insufficiently considered. Measures for climate change mitigation and safeguarding biodiversity are generally considered multifunctional and can simultaneously contribute to both water quality conservation and erosion prevention (Galler *et al*., 2015). It is also noted by Galler *et al*. that, where large areas of the agricultural land were not included in biodiversity measures, the synergies with other ecosystem services, such as climate change and water services, were reduced. This highlighted the potential of large contiguous areas of HNV to deliver multiple benefits in terms of ecosystem services. These climate change and biodiversity measures are considered the most costly because of the required changes in land use and extensive restrictions on use (Galler *et al*., 2015), which is the case in intensive farming areas. However, the implementation cost may not be as high in HNV farmland areas as extensive farming practices are already in place. Measures with improved spatial targeting directed at water quality and regulating flooding, in combination with maintenance and enhancement of existing HNV farming systems (and associated biodiversity features) could deliver multiple benefits. The combination of wider ecosystem services into river basin management plans in an integrated catchment management approach could be a mechanism to move from a single- to a multi-objective decision-making approach in the design and prioritisation of management actions (Terrado *et al*., 2016).

There is a real need for integrated strategies that are adapted to the range of farming systems that exist (extensive whole HNV through to intensively farmed land) to realise co-benefits for water and biodiversity while maintaining essential production services such as food and fibre provision. As highlighted in section 2.3, we must recognise that in many areas there may be a range of farm types along the HNV–intensive farmland spectrum and, even within HNV farms, there will be a range of intensities between fields, which highlights the need for targeting of measures at various spatial scales from field to catchment or landscape.

5 Conclusions and Recommendations

Predominantly, HNV farmland occurs in the west and upland areas of the country and has high spatial coincidence with high-status water and the headwater streams of larger downstream rivers. The management of HNV farmland for biodiversity has the potential to have co-benefits for water quality and quantity, such as the regulation of flooding and maintaining base flow. Improved co-ordination and spatial targeting of initiatives for HNV farmland could play a major role in meeting the requirements of the Water Framework Directive and the Birds and Habitats Directives. Different approaches are required to meet Water Framework Directive targets on HNV farmland compared with intensive farmland. In HNV farmland areas there needs to be a focus on the promotion of farming activities that meet water and biodiversity objectives, rather than a focus on mitigation actions that may be required for activities associated with intensive agricultural practices. A framework needs to be developed that maps out a pathway for the development of integrated approaches for the management of our land, water and living resources to ensure sustainable use.

The spatial heterogeneity in land capacity and the range of intensities of farming in Ireland from low-intensity HNV farmland to intensive farming systems highlights that approaches need to be locally adapted within a broader framework. There is a real need to expand the range of locally led integrated catchment/landscape management initiatives, which aim to simultaneously provide multiple ecosystem services. These initiatives must take a participatory and partnership approach that will encourage an innovative network of stakeholders working in partnership to develop locally adapted and results-orientated solutions. Success factors for local initiatives, such as the Burren Programme, highlight the need to secure a broad range of stakeholder involvement and the key role of dedicated community “champions” to take the initiative and drive innovation. Initiatives need to be targeted to specific areas, locally adapted and focused on results. A flexible and adaptive management approach that is well researched and knowledge based is needed; this recognises the value of sound science and traditional knowledge. Local initiatives need to be supported by state agencies and government departments with an integrated knowledge transfer or advisory service.

We need to be cognisant of the wider policy setting and, in particular, the growing demand for a wide range of private and public goods and services in the context of growing populations and a finite resource base. Scotland’s recent development of a land use strategy can provide many lessons for Ireland and highlights the challenges in trying to maximise benefits while minimising the trade-offs in the delivery of multiple services (Slee *et al*., 2014). In Scotland, as in Ireland, many of the areas dominated by HNV farmland are designated for nature and landscape conservation and the most productive farmland has a clear focus on food production. However, as can be seen in Figure 2.2, we have a very diverse range of land types in Ireland, as in Scotland, and many areas do not neatly fit into either of the two extremes. The so-called squeezed middle (Slee *et al*., 2014) in Scotland (corresponding to the light green and yellow areas in Figure 2.2 in Ireland) are the areas with many competing land use pressures leading to land use conflict. These land use conflicts are experienced across the spectrum in Ireland, but at least at the two extremes the policy objectives can be clearer. Scotland’s land use strategy recognises that the best agricultural land should be prioritised mainly for agricultural production, and that at the other extreme the land with limited options for productive agricultural use is valued more for public goods and ecosystem services, such as landscape amenity and biodiversity and as a carbon store. Many of the additional demands for land-based ecosystem services fall on the intermediate-quality farmland zone (Slee *et al*., 2014). The farmers in these areas in Ireland are similarly confronted by multiple, often conflicting demands, as the farmland can support extensive livestock farming; often has high potential for forestry; contains landscapes valued for their biodiversity, recreation and cultural values; and has potential for renewable energy generation and water provision. Policy objectives for different land use types and the services required from the range of agricultural land use intensities in Ireland need to be much clearer. The complex policy demands, coupled with the heterogeneity of the land base, further highlight the need for translation of clear national policy into local initiatives.

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Abbreviations

ANCs	Areas of Natural Constraint
CAP	Common Agricultural Policy
CMEF	Common Monitoring and Evaluation Framework
DPSIR	Driving forces–pressures–state–impact–response (pathways)
EAFRD	European Agricultural Fund for Rural Development
ED	Electoral division
EFNCP	European Forum on Nature Conservation and Pastoralism
EPA	Environmental Protection Agency
GLAS	Green Low-Carbon Agri-environment Scheme
HNV	High Nature Value
Link	Learning, Innovation and Knowledge
LLAES	Locally led agri-environment schemes
RDP	Rural Development Programme