Research Report No. 1201

Preparing the Evidence Base for Post-Brexit agriculture in Scotland – case studies on alternative payments

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RESEARCH REPORT

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RESEARCH REPORT

Summary

Preparing the Evidence Base for Post-Brexit agriculture in Scotland – case studies on alternative payments

Research Report No. 1201
Project No: 117280
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Keywords

public goods; agri-environment; policy; environmental maintenance; conservation agriculture; organic farming; agroforestry; habitat conservation; nature restoration

Background

Leaving the European Union will present significant challenges to the farming industry, and creative change is required for a new agricultural policy after the transition period. Many farms rely on public support and there is a need to review possible solutions that will replace and improve on the Common Agricultural Policy, for both the industry and wider society. In particular, could the resources currently spent on CAP basic and coupled payments be redirected to pay for the delivery of public environmental goods? This study aims to contribute to preparing the evidence for post-Brexit agricultural and environmental support in this context. The results are intended to provide a basis for discussion and an illustration of how various proposals for supporting agriculture and the environment after exiting the EU could be applied.

The objectives of this study are to:

- illustrate how the concept of public money for public goods could be realised across a range of farm types in Scotland;
- using case studies, make a comparison of current agricultural support with alternative proposals for rewarding farmers for the delivery of environmental public goods;
- assess the impact on farm income of the various proposals compared with current pillar 1 and pillar 2 payments on the selected farms; and
- discuss the feasibility, potential risks, and advantages of the various proposals, based on expert opinion.

In addition to this report, five summaries of the different farm types studied have been produced for a general audience, as well as a fact sheet on public goods.

Main findings

Public goods are all the things we enjoy and value in life, but we cannot buy the way we do with other goods. In the context of agriculture, public goods generally refer to those activities for which there is no direct market at present. Public goods generated by agriculture cover a wide range of themes, from climate change mitigation and adaptation to water quality, air quality, soil health, biodiversity conservation, public access and public health and socio-economic themes.

A wide range of options exist to enhance the environmental public goods generated by agriculture. This study has focused on three groups of options:

1. **Environmental maintenance and improvement** options focus on input-use reduction while maintaining output (improved efficiency), and on the use of a proportion of agricultural land (e.g. field margins) for primarily environmental purposes.

2. **Multi-functional, agroecological farming systems**, such as conservation agriculture, organic farming, and agroforestry, can further enhance the delivery of public environmental benefits while maintaining agricultural land for food and fibre production. High nature value (HNV) farming is also relevant in this context, but was not modelled directly due to the constraints of the approach used and the variability in practices involved.

3. **Environment enhancement, habitat conservation (including peatland) and nature restoration** options go a stage further in delivering public goods, but also involve a shift in the primary function of some farmland from agriculture to the production of environmental benefits.

Case studies were undertaken focused on five farm types (arable, dairy, lowland livestock, hill sheep and crofting) involving data from both Farm Business Survey (FBS) farms and from individual farms participating in the study.

A financial impact modelling was undertaken with the ScotFarm model, using both representative FBS data and data from the individual case study farms. Separate calculations based on pro rata adjustments were undertaken for the habitat conservation and nature restoration options, as these were not amenable to direct evaluation with the modelling approach used. The analysis shows both positive and negative financial outcomes for different options, with results varying sometimes substantially by farm type.

The case study farmer reactions to options were to some extent consistent with the financial impact assessments, with for example arable and dairy farmers preferring more entry-level environmental maintenance and improvement options, possibly linked to hedgerow variants of agroforestry. Hill farmers and crofters considered these less relevant, but were more interested in moorland habitat management and shelterbelt agroforestry. However, some of the options, such as agroforestry and nature restoration, were less well understood by the farmers, illustrating the need for advisory, training and information input.

The concept of reallocating CAP basic and coupled payments to paying for options delivering environmental public goods is also examined for different hypothetical scenarios on each farm type. The starting point for this study was that current basic and coupled support would be reallocated to pay for public goods. In practice, the resulting level of support would depend on the farmer's choice and uptake of options, as well as the amounts of public goods which the various options might deliver.

While the projections are based on a number of assumptions and are therefore considered for illustrative purposes only, this study shows that individual farms may be able to retain all or a significant proportion of their current CAP support income. This will vary depending on the options selected, the allocation formula used and the delivery costs for the options on different farm types. There is a contrast in the optimal solutions for each farm type to maintain farm income. The proportion of current support allocated to each option could be determined by a combination of the public goods generated, and the income foregone/costs incurred in doing so.

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1. INTRODUCTION

1.1 Background

Leaving the European Union will present significant challenges to the farming industry, and creative change is required for a new agricultural policy after the transition period. Many farms rely on public support and there is a need to review possible solutions that will replace and improve on the Common Agricultural Policy (CAP), for both the industry and wider society.

Under the Common Agricultural Policy, the delivery of environmental public goods is rewarded, amongst other objectives, through agri-environment options funded under the Rural Development Programme. This system, which involves payment based on income foregone and the design of prescriptive options, has delivered in some respects, but has been unsatisfactory in others. The top-down and prescriptive approach has failed to engage farmers in a way that would give them ownership of the delivery of environmental goods. The competitive nature of agri-environment schemes means that not all land managers who want to carry out positive management for the environment are supported financially to do so. A related issue is the availability of overall funding to support environmental outcomes. While farmers voluntarily enter into agri-environment schemes, the schemes have become increasingly complex, partially in response to regulatory, audit and compliance issues. This has acted as a disincentive for some farmers and crofters to apply. Benefits on the ground can also be lost due to the cyclical nature of support. Monitoring evidence has shown biodiversity gains for certain options, but overall. The results from agri-environment measures are not well understood, in large part because of insufficient monitoring, hence the value for public money over the years is not always clear.

Ahead of the UK and Scotland's exit from the European Union, various discussion papers and visions have been published on the delivery of public goods post-Brexit[1], as well as public consultations on a reformed agricultural policy. The Agricultural Champions delivered their report[2] to the Scottish Government in 2018 stating that 'no change' is not an option and farm support is an asset given by the public to farmers and crofters to help them improve their business and deliver what the marketplace does not fund.

Various organisations (e.g. Scottish Wildlife Trust[3], Yorkshire Wildlife Trust[4], Scottish Environment LINK[5], Game and Wildlife Conservation Trust England[6]) have proposed new ways of supporting and rewarding farmers for the delivery of environmental goods and ensuring sustainable food production.

Similar debates are taking place in the context of CAP reform; in particular the introduction of the new Eco-schemes[7] in Pillar 1, and an increased emphasis on results-based approaches, both at Member State and farm level.

This project aims to contribute to preparing the evidence for post-Brexit agricultural and environmental support. It does not, however, aim to provide a comprehensive evidence base to develop future agricultural policy. Instead, the project and the case studies are intended to provide a basis for discussion and an illustration of how various proposals for supporting agriculture and the environment after exiting the EU could be applied.

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[1] e.g. Scottish Land and Estates (A new Direction for Scottish Land management), Scottish Environment LINK (Renewing Scotland's Rural Areas), Scottish Wildlife Trust (Land Stewardship)
[2] https://www.gov.scot/publications/future-strategy-scottish-agriculture-final-report-scottish-governments-agriculture-champions/
[3] https://scottishwildlifetrust.org.uk/our-work/our-advocacy/policies-and-positions/land-stewardship-policy/
[4] https://www.ywt.org.uk/news/applying-new-approach-english-agricultural-policy-post-brexit
[5] https://www.scotlink.org/files/LINK-Future-of-Farming-and-Rural-Land-Management_March2017.pdf
[6] https://www.gwct.org.uk/media/878712/farming-through-brexit-lr.pdf
[7] https://www.ifoam-eu.org/sites/default/files/ifoam-eco-schemes-web.pdf

1.2 Objectives

The objectives of this study are to:

- illustrate how the concept of public money for public goods could be realised across a range of farm types in Scotland;
- using case studies, make a comparison of current agricultural support with alternative proposals for rewarding farmers for the delivery of environmental public goods;
- assess the impact on farm income of the various proposals compared with current pillar 1 and pillar 2 payments on the selected farms; and
- discuss the feasibility, potential risks, and advantages of the various proposals, based on expert opinion.

In addition to this report, five case studies of the different farm types studied have been produced for a general audience.

1.3 Approach

The following activities have been undertaken to address the specified objectives:

1. A conceptual review of the nature of public goods and the potential for better rewarding their delivery within the context of the Scottish Agricultural environment (Chapter 2).
2. A review of the alternative options for agri-environmental measures that might be adopted in the context of future policy (Chapter 3). While the initial review has been drawn broadly, a subset of the measures has been selected for more detailed evaluation.
3. Case studies of five key Scottish farm types (arable, dairy, lowland livestock, hill sheep and crofting) have been undertaken at three levels:
    a. A descriptive summary of structural and farm business survey data relevant to the farm type (Chapter 4).
    b. Modelling of the impacts of alternative options on four of the farm types (excluding crofting) where sufficient data is available to define representative farms (Chapter 6).
    c. An assessment of the potential of the options evaluated on actual farms representing the five case study types (one each for the four types with representative farms (see 3b) and two in the case of crofting. The assessments included:
        - the use of sustainability assessments on each of the farms to identify the strengths and weaknesses of the systems (Chapter 5);
        - the identification of relevant options for the farms based on the assessment and the financial modelling of the alternative options for these actual farms (Chapter 6); and
        - an assessment of the farmers' reactions to the results and options.
4. A concluding review of the options based on the results, the feedback received and the expert opinions contained within the study team and the project steering group.

2. PUBLIC GOODS: CONCEPTS AND CHALLENGES

2.1 Introduction

The concept of public money for public goods has moved significantly up the public agenda in recent years, particularly in the context of post-CAP agricultural policy in the UK. In market economies, it is traditionally argued that governments should not intervene where markets are functioning well, but in cases of market failure there may be a case for government intervention. This may take the form of regulations to restrict activities, or of financial or other support to enable activities, or limitations on activities, that would not otherwise take place.

In the case of agricultural and environmental policy making, common types of market failure include:

- infant industries, where nurturing of worthwhile new sectors/businesses might be required until they are able to compete against established businesses;
- information-deficits, where insufficient technical or market data is in the public domain to enable markets to work effectively;
- market volatility, in particular where this is due to external factors, including weather and trade or other conflicts that are outside the control of market actors – volatility arising from weather conditions particularly affects agriculture with potentially significant societal impacts in terms of food availability and price;
- market power imbalances, where mismatched market structures can lead to exploitation; and
- absence of markets for outcomes of societal benefit, typically referred to as public goods, but potentially also including negative externalities.

The last of these is of particular importance for this study, although others may also be relevant in certain situations.

In this chapter, we propose a definition of what public goods are in an agricultural context, and a description of marketable goods versus non-marketable goods, based on our expert opinion, key literature and discussions with the NatureScot steering group. The discussion includes reference to natural capital/resource concepts and externalities, and identifies the range of categories of externalities/public goods/benefits that might be included. It should be noted that there is a case that the reduction of some environmental harms might still be considered a public benefit, if the costs currently carried by the public to mitigate the harm are reduced, though this might also be achieved through tightening regulation or fiscal means.

We also consider whether there is a case that specific public goods may be higher priority than others in a Scottish context.

2.2 Definitions of public goods and externalities

The term 'public goods' in economics can be considered in contrast to 'private goods'[8]. Private goods are those that can be exchanged between market actors (whether producers,

[8] Samuelson, P.A. 1954. The Pure Theory of Public Expenditure. *Review of Economics and Statistics*, 36:387–89.
For an agricultural policy perspective, see also:
Cooper, T., Hart, K., & Baldock, D. 2009. *The Provision of* Public Goods *Through Agriculture in the European Union*. Report Prepared for DG Agri, European Commission by IEEP, Brussels.
Bateman, D.I. 1994. Organic farming and society: an economic perspective. In: Lampkin, N. & Padel, S. (eds.) *The Economics of Organic Farming – an International Perspective.* CABI, Wallingford.

intermediaries or consumers), where the market mechanism acts to reconcile consumer willingness to pay a certain price and the producer's willingness (or ability) to supply products at that price. In theory at least, the higher the demand from consumers, the higher the price they will need to be willing to pay if supply is fixed in the short term. In the longer term, the markets will clear as more producers will be willing to supply at the higher prices. If for some reason demand falls, then surplus product will be on the market, and prices will need to fall in order to dispose of the surpluses. In an ideal world, this market mechanism should be able to operate without external intervention.

As indicated above, there are many reasons why markets may fail to operate in this ideal sense. Of particular relevance in this study are some that are often encountered within the realm of environmental economics:

- market actors may lack knowledge of or be unaware of the full impacts of their transactions, so that their values, including ethical values, are not fully reflected in their decision-making;
- some (or all) of the costs and benefits relating to the transaction may not be recognised because they are not normally traded and therefore no price exists for that part of the transaction; and
- some of the costs and benefits may fall on third parties, who may be other members of society, or future generations, who are not party to the original transaction.

In general terms, these all represent examples of an absence of property rights, often referred to as externalities. An externality exists when there is an unpriced interdependency between two economic agents. Externalities may be positive – a farmer planting trees for commercial use could create landscape and recreational benefits for visitors. They may also be negative – for example where farming practices lead to pollution of water supplies. In theory at least, if a market – i.e. property rights – could be created for the particular benefit or disbenefit, then the market mechanism could be used to determine the 'optimal' level of the externality.

A further problem arises where interests are shared between many individuals, or between common property rights, as opposed to single individual property rights. Even if a market mechanism could be established to address the externality, the problem with common property rights is how to make all beneficiaries (or those impacted) contribute. This can occur for example with diffuse pollution, where the pollution has an impact on one actor, for example a water company, but the actors e.g. the individual farmers, causing the pollution cannot be separately identified. Alternatively, advantage may be taken of the common good by 'free-riders' who make no contribution to it – a problem well illustrated by over-grazing of common land.

Building on this, pure public goods can be defined as having characteristics that are the opposite of private goods, i.e.:

- non-excludability: the benefits derived from pure public goods cannot be confined solely to those who have paid for it, with free-riders enjoying the benefits while making no contribution;
- non-rival consumption: consumption by one actor does not prevent consumption by others; and
- non-rejectable: the collective supply of a public good cannot be rejected by individuals, as in a flood defence system.

While the term public goods is currently widely used in the debate, there are in practice relatively few examples of pure public goods that strictly meet this definition. Quasi-public goods may exist where they are only partly excludable or non-rival, for example roads used by too much traffic will become congested. In practice, the debate is more widely drawn to

encompass a broader range of public or societal benefits, which might include reductions in negative externalities that reduce mitigation costs to society.

Since almost any form of agriculture has some form of environmental cost, it can be quite difficult to distinguish between circumstances in which the polluter pays principle should apply and those where the farmer is making a sufficient improvement on normal good practice to constitute the creation of a public benefit, in which case there may be a case for offering a payment. For example, the use of metaldehyde slug controls by farmers causes significant diffuse pollution problems that can be difficult to attribute directly to individuals[9], the mitigation costs of which are borne by water companies on behalf of water consumers, in practice the general public. Governments can seek to modify farmer behaviour through information campaigns or by imposing input taxes (reflecting the polluter pays principle). Or they can effectively nationalise the property rights through regulation, by defining how and when an input may be used, or by taking away permission to use the input[10].

The public benefit of reducing or stopping the negative externality (or public bad), is the reduced cost of securing clean water supplies, rather than a public good as such. However, paying farmers a positive financial incentive to reduce metaldehyde use generally, where still permitted, could be seen as conflicting with the polluter pays principle, unless there was no viable, environmentally acceptable alternative available.

Where an activity is prohibited or required by regulation, then compliance with the regulation cannot constitute delivering a public good that might be paid for, given that the right to produce the good has effectively been nationalised. But if a producer goes beyond the minimum or maximum threshold required by the regulation, then the additional delivery may be considered eligible for incentives to stimulate further public goods.

These arguments potentially apply to most measures to restore farmland biodiversity, which in effect are mitigating against the harm caused to wildlife by farming. They could also apply to many measures for carbon sequestration on farmland, such as tree planting to offset emissions from agriculture, or restoration of peatlands to redress the impact of drainage previously undertaken to gain agricultural land. Arguably, most agri-environment measures of this type go against the polluter pays principle and the pure concept of public goods. Farmed landscapes valued by the public for aesthetic or recreational reasons, or flood management facilities developed and maintained by farmers but benefitting communities downstream, are much more consistent with the standard public good definitions.

A mixed approach of public (government) and market actor interventions may be relevant in some situations. For example, organic farming standards restrict the use of many agrochemicals associated with diffuse pollution and greenhouse gas emissions. The market for organic food provides a mechanism by which consumers willing to pay extra can (at least in part) recompense organic farmers for forgoing the use of those inputs that non-organic farmers are still permitted to use, and incurring the associated yield penalties, while jointly generating a number of other public goods in the process. However, if the benefits are accruing to a much wider public than those willing to pay for organic food, then there is a free-rider problem that may justify government intervention to provide additional financial support to such producers. In some cases, other market actors, for example water companies, may

[9] Castle, G.D., Mills, G.A., Gravell, A., Jones, L., Townsend, I., Cameron, D.G. & Fones, G.R. 2017. Review of the molluscicide metaldehyde in the environment. *Environ. Sci.: Water Res. Technol.*, 3:415-428.

[10] Defra's plans to prohibit metaldehyde use were overturned following a legal challenge from the manufacturers in July 2019. https://www.fwi.co.uk/arable/crop-management/pests/metaldehyde-slug-pellet-ban-overturned-after-legal-challenge

have a direct interest in encouraging organic management of land in polluted catchments in order to reduce the clean-up costs, particularly if the financial payments they provide to farmers are less than the costs incurred.

Public goods have a foundation in fundamental human requirements such as collective security and survival. However, the particular way that they are formulated, and the value placed on them at any specific time, will reflect contemporary perceptions and concerns as well as indisputable facts. To some degree, they are negotiable in a democratic system, to the extent that the allocation of limited resources to specific issues will be influenced by political priorities, and their precise constituents can change over time. In the case of the environment, our understanding of the levels of threat to future survival and quality of life is in a process of evolution, building on growing evidence. There can be a lag between the understanding of scientists and specialists and that of the general public, as well as conflicts in priorities between current and future generations. This can create a tension that policy makers will need to handle sensitively in formulating the working definitions of public goods that are deployed in legal and economic interventions, such as agricultural policy. The role of peatland management in climate regulation may be more apparent to specialists than the general public for example, but this is not a reason to exclude payments for restoration from a new agri-environment scheme.

At the same time, differences in understanding and levels of knowledge, in society generally and specifically in policy target groups, need to be acknowledged and addressed where appropriate. For example, not all wildlife is perceived as a good thing by different groups; snakes, spiders, wasps, badgers, foxes, beavers and wolves have their detractors, despite the ecosystem services that they undoubtedly contribute in specific contexts[11]. Sectors of society with a range of perspectives and levels of knowledge may see things differently, but in general terms awareness of environmental issues is increasing, and with it recognition of the case for supporting public goods. This is one of several reasons for incorporating active engagement, information and advice in a new public goods oriented policy.

2.3 Natural capital/resources and payments for ecosystem services

It can be argued that natural capital and the ecosystem services derived from natural resources are a special case in this debate.

Natural capital can be defined as the *stock* of natural resources, which includes geology, soils, air, water, and all living organisms. The term is an extension of the traditional economic concepts of land, labour and capital, where ‘land’ embodied all the natural resources used in production, ‘labour’ the human resources employed, and ‘capital’ the conversion of natural resources through human intervention into stocks of productive resources such as machinery and buildings.

Ecosystem services can be defined as the *flow* of goods and services from natural capital/resources, benefiting humans either directly (through supporting and provisioning services, e.g. fresh water, food, fuel and timber production), or through the maintenance of clean and healthy ecosystems (regulating services, e.g. climate, disease, pollination etc.). Although the concept of ecosystem services is focused on humans, there are also implications for other species. Over-exploitation of ecosystem services is clearly possible, resulting in the

[11] Bateman, D.I. 1994. Organic farming and society: an economic perspective. In: Lampkin, N. & Padel, S. (eds.) *The Economics of Organic Farming – an International Perspective*. CABI, Wallingford.

degradation or loss of natural capital, which can also be considered as a negative externality or public disbenefit.

Although often perceived as 'natural', i.e. not resulting from, or influenced by, human intervention, ecosystem services and natural capital can be positively influenced (maintained and/or enhanced) by human intervention, for example by producing particular crops that build soil organic matter or encourage pollinators. While such interventions may not always meet the criteria for pure public goods, they may still give rise to a significant public benefit.

Given this and the rather variable degree to which the environmental imperatives with respect to land management and agriculture could be considered as pure public goods, as seen in the previous section, there is a case for using the term "public benefit" as a working alternative for policy purposes. We have adopted this terminology in the remainder of the report but do not intend to suggest that this is a departure from the essential thrust of a public goods focussed policy as understood in current agricultural policy debates.

2.4 Other relevant concepts

Some economists have attempted to extend these concepts further to consider a much wider range of 'values', 'capitals' or 'wellbeings' that could act as a focus for analysis. Saunders (2019)[12] for example identifies seven different capitals: human, cultural, social, economic, natural, knowledge and diplomatic. If public policy is primarily interested in the promotion of human wellbeing, then there needs to be engagement with all these different capital types.

While this is clearly recognised, the focus of this study is specifically restricted to natural capital, ecosystems services, and public environmental benefits.

2.5 Relevant categories of public goods from agriculture meriting policy intervention

In terms of the current study and policy debate, the following (see also Figure 2.1) may be characterised as relevant public benefits, if not pure public goods, that farmers generally have agency over, and which might be targets for policy intervention (not in any particular order of priority)[13,14]. It is recognised that some of the actions proposed may have both private and public benefits, and may impact on more than one of the issues identified.

[12] Saunders, C. 2019. Sustainable agriculture – life beyond subsidies: Lessons from New Zealand. *Journal of Agricultural Economics* 70:579-594. See also Dalziel, Saunders & Saunders. 2018. *Wellbeing Economics: The Capabilities Approach to Prosperity.*

[13] Although focused on England, the 25-year Environment Plan (Defra, 2018) specifies ten public benefits as a focus. The mapping to the list presented here is shown in parentheses after each one: a. Clean air (4,5,7,12); b. Clean and plentiful water (1,2); c. Thriving plants and wildlife (8,9); d. Reducing risk of harm from environmental hazards e.g. flooding (2,7); e. Using natural resources more sustainably and efficiently (3,12,15,17); f. Enhancing beauty, heritage and engagement with the natural environment (10,11); g. Mitigating and adapting to climate change (5,6); h. Minimising waste (5,12); i. Managing exposure to chemicals (1,5,8,12); j. Enhancing bio security (8,15). Farm animal health and welfare, and Public health and Culture, are not specifically identified, although impacted by some of the specified goals.

[14] See also Cooper. T., Hart. K. & Baldock, D. 2009. *Provision of Public Goods through Agriculture in the European Union.* IEEP, Brussels.

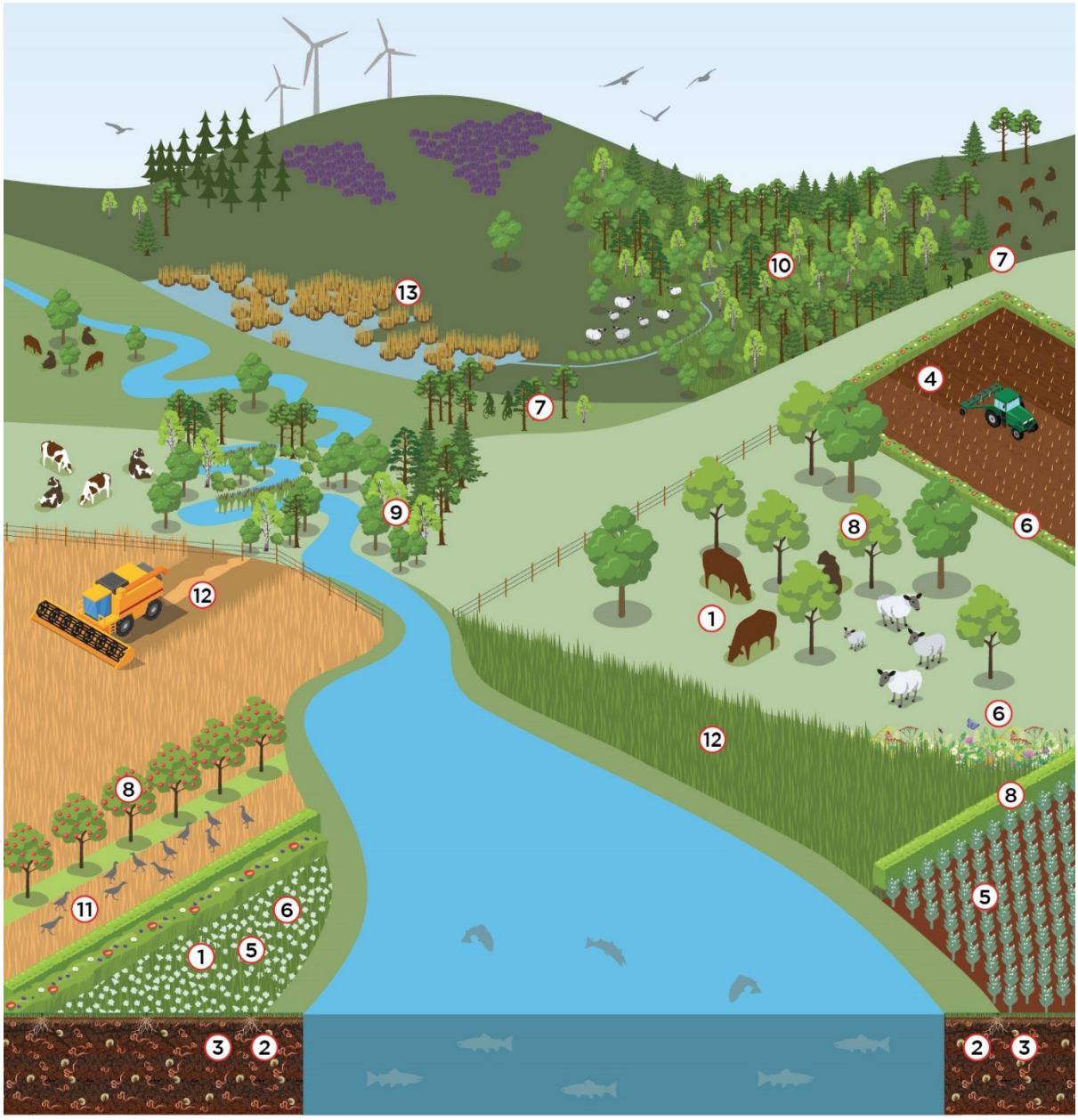

Figure 2.1 Schematic illustration of environmental public goods delivered by agriculture

Source: Own compilation

1. Water quality: Clean water is important for public health and for the health of ecosystems, as pollution impacts negatively on aquatic and marine ecosystems, for example through eutrophication and algal blooms. Agriculture contributes towards both diffuse and point sources of pollution (from fertilisers, manures and slurries, soil erosion and pesticide applications). Some aspects of pollution risk are covered by regulation, e.g. the Nitrates Directive. Appropriate agricultural practices can lead to reductions in pollution load, for example through soil filtration of water, with nutrients and soil particles captured by soil organic matter. Actions to improve water quality that go beyond regulatory requirements generate public goods of particular interest to water and environmental protection agencies.

2. Flood protection and drought control: Changes in land use and management (e.g. drainage, conversion to arable) have impacted on the ability of soils to moderate water flows in catchments, causing significant flooding incidents and economic damage. Some management practices (including cultivations causing compaction and fertiliser use affecting nutrient availability and acidity in the soil profile) can also impact negatively on plant root development and soil earthworm activity, reducing infiltration rates and increasing surface runoff. Conversely, reduced nitrogen fertiliser use, the conversion of arable land to low-input grass, agroforestry tree lines, riverbank restoration and floodplain management can all make positive contributions, both to reducing flood risks and improving drought resilience. Some of these measures are also likely to provide additional public goods such as improvements to biodiversity. Actions of this type are normally not required by regulations, with the public goods of particular interest to agencies concerned with water and flood risk management.

3. Soil health (functionality) and organic matter: Healthy soils are perceived as a significant component of natural capital in recognition of their provision of key ecosystems services, including food production. However, because food and the fertilisers used to produce it are marketable products, not all aspects of soil health (e.g. soil nutrient status) are generally regarded as public goods. Sufficiently high levels of organic matter and soil biological activity, however, can be considered to be important in terms of natural capital and public goods. Both play an important part in soil conservation, reducing erosion, flood and pollution risks as well as supporting carbon sequestration. While some aspects of soil protection are covered by regulations including GAEC[15] cross-compliance conditions, a range of actions to build soil organic matter, such as the inclusion of green manures and leys in extended rotations, the recycling of organic matter and crop residues, and reductions in agrochemical inputs that can impact negatively on soil organisms, can generate public goods beyond regulatory requirements. These benefits may not be reflected in improved technical performance and may in some cases restrict the production of private goods such as crops in the short term. In the longer term, while there will be private benefits from healthy soils, these may not be fully reflected in land prices and inter-generational transfers.

4. Air quality: Clean air is important for public health. High loadings with agriculturally generated emissions such as ammonia (NH_3) can also lead to excessive nitrogen depositions, which can adversely affect sensitive habitats such as bogs, as well as impact on animal health. Conversely, planting of trees, for example in agroforestry systems, can help to capture and remove ammonia, reducing negative impacts. Nitrogen oxide, particulates and other emissions from diesel use in farm vehicles and equipment are also a relevant public health concern. The same is true for farm waste and crop residue burning, although many of these activities are now controlled by

[15] https://www.ruralpayments.org/publicsite/futures/topics/inspections/all-inspections/cross-compliance/detailed-guidance/good-agricultural-and-environmental-conditions/

regulations. Spray drift from the application of pesticides is also a potential issue in certain situations, even though codes of practice exist to try to limit the risks. Relevant actions which go beyond regulatory requirements and generate public goods include substantially reducing the use of pesticides (for example in organic and advanced integrated pest management (IPM) systems) and appropriately located and designed farm woodlands and agroforestry systems.

5. Climate change mitigation: Agriculture is associated with a range of greenhouse gas emissions that contribute to climate change, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and indirectly ammonia (NH_3, measured through impacts on N_2O emissions). Agricultural CO_2 emissions result from the use of fossil energy for transport and farm mechanisation, as well as the breakdown of organic matter in soils and animal digestion. Conversely as a biological, plant-based industry, agriculture also has the potential to fix CO_2 through photosynthesis and in certain circumstances to sequester carbon in wood and soils for longer periods. For example, extensive livestock systems which rely on grazing of permanent and/or semi-natural grasslands may contribute to carbon sequestration. N_2O emissions are particularly associated with the use of fertilisers, while CH_4 is more usually associated with livestock production and the storage and spreading of manures and slurries. Some GHG emissions, for example associated with agrochemical manufacture or the production of animal feeds abroad, may not be counted as domestic agricultural emissions, but are also relevant. A wide range of improved practices with respect to cropping systems, soil management, fertiliser use, animal nutrition, health and manure management have been identified, which might reduce emissions[16]. Reducing food waste, and hence the need for food production, as well as reducing or reversing land use change from trees, peat bogs and permanent grassland to agriculture are also highly relevant. All such practices that go beyond regulatory requirements generate public goods, in some cases at additional cost, but may also contribute to improved productivity.

6. Climate change adaptation: Many of the impacts of climate change are expected to be felt as more extreme weather conditions (hotter summers, more wet winters, more extreme rain and snow events). Farmers and other land managers can contribute to the broader societal challenge of adaptation through efforts to moderate flood risks (see above), hedge and broadleaf tree planting to improve micro-climates (e.g. through shading) and maintaining soil cover to protect soils from erosion. Amongst the considerable range of such practices, a proportion will go beyond private interests and regulatory requirements and will generate public goods.

7. Fire resilience: This is often more associated with dryland or Mediterranean systems and forest fires, but drier weather conditions in the UK have resulted in increasing incidences of moorland fires affecting farmland, biodiversity, livestock and the built environment, both through fire itself and the impacts on air quality. Management practices to reduce the potential for fires spreading, and the ability to control fires when they do happen (e.g. though improved water storage facilities), can generate wider public goods beyond the interests of individual farms.

8. Farmland biodiversity: Forms of biodiversity that can be affected, directly or indirectly, by agricultural practices include a wide range of ecosystems, habitats and species, from soil micro-organisms, invertebrates and plants to mammals and birds. Many species and habitats are adversely affected by agricultural activity and there is a case for some conversion of agricultural land to wild habitat (nature restoration) as well as specifically protecting remnant habitats and species, including veteran trees. However,

[16] Lampkin, N., Smith, L., Padel, K. 2019. *Delivering on net zero: Scottish agriculture.* WWF Scotland, Edinburgh.

many wild species have adapted to and co-exist with agricultural land management and have been adversely impacted by the intensification of agriculture, and in particular the use of agrochemicals. For farmland biodiversity, there is a well-evidenced case for reducing farming intensity and providing wildlife refuges and habitats (land sharing), as well as for a shift in perspective to consider how biodiversity can benefit agriculture through the provision of ecosystem services such as pollination and pest/disease control[17]. Practices that go beyond regulatory requirements generate public goods, potentially at the expense of the production of private goods.

9. Pollinators: These have an important role in enabling plant reproduction, including in many agricultural crops. Legumes and other flowering species in field margins, diverse leys and extended crop rotations can support pollinators, but changes in, for example, grassland cutting practices for hay and silage may be required to ensure food sources continue to be available through the growing season. Activities specifically to support pollinators beyond the normal commercial interests of producers are not normally required by regulation and therefore are likely to qualify as wider public goods. Drawing the boundaries between public and private benefits can be difficult, as also discussed for soil management practices above.

10. Agricultural landscapes: Given that most land in the UK is farmed, the resulting agricultural landscapes and their management can impact on public recreation and tourism, with related public health impacts. Some landscapes may be marketable, through access and parking charges, or tourism-related accommodation and catering facilities. However, this is not usually the case and often the overall landscape impact is the result of activities on multiple holdings, and not directly related to individual land managers or providers of tourism services. The quality of agricultural landscapes can be negatively impacted by large-scale monocultures (crops, tree plantations) and livestock grazing, although in some cases the wide-open spaces created by sheep and deer grazing may be seen by some as inherently attractive. The provision of landscape elements (including trees, hedges, copses, and ponds), the reduction of field sizes and the diversification of cropping systems can all generate public goods, such as contributing to more attractive landscapes, without providing marketable outputs to the landowner.

11. Public access to land: With a largely private land-ownership structure, access to land is already recognised as a public good through the granting of a right of access open to all under the Land Reform Act[18] in Scotland. However, public policy considerations relating to the enjoyment of the countryside, recreation and health determine that in order for access to happen, there is a need to provide facilities and/or maintain these. This provision includes enabling people in centres of population to reach rural land.

12. Conservation of non-renewable resources: This covers the management of a wide range of agricultural inputs, including: fossil energy for transport, machinery, farm operations and agrochemical and other input manufacture; nutrients such as phosphorus and potassium; materials including concrete, plastic, metals for buildings and other structures; and much more. Some resources that are potentially renewable, including soil, water and biological organisms of all types, may be rendered non-renewable through over exploitation and degradation (a key focus for natural capital considerations). Circular economy principles, including waste minimisation (outputs as

[17] Lampkin, N.H., Pearce, B.D., Leake, A.R., Creissen, H., Gerrard, C.L., Girling, R., Lloyd, S., Padel, S., Smith, J., Smith, L.G., Vieweger, A. & Wolfe, M.S. 2015. *The role of agroecology in sustainable intensification*. Report for the Land Use Policy Group. Organic Research Centre, Newbury and Game & Wildlife Conservation Trust, Fordingbridge.

[18] https://www.outdooraccess-scotland.scot/

well as inputs) and the closing of cycles (e.g. retaining resources, reducing waste and returning nutrients exported to urban areas back to the land, rather than losing them to the wider environment) are key issues to be addressed. While the extraction and utilisation of these resources is treated generally as the supply of marketable private goods, the consequences of the externalities arising and the inter-generational issues of depleting natural capital and exhausting the supply of non-renewable resources are matters of public concern. Some aspects of reducing non-renewable resource use, and using renewable resources more sustainably, can therefore be considered as public goods.

13. Farm animal welfare and animal health: This is a topic often not included in environmental or social sustainability assessments or considered as a public benefit. To the extent that poor animal health impacts on productivity, then actions to address animal health issues are related to the production of private goods. However, some animal health issues may be more directly linked to production inefficiencies generating GHG emissions, or creating epidemic control, food safety and public health issues. Particularly where disease vectors are outside the control of individual producers (e.g. Foot and Mouth, TB), control may be seen as a significant public policy issue associated with the generation of public goods. Farm animal welfare, particularly issues relating to mutilations, housing, confinement and freedom to express natural behaviours, is more complex because in some cases there may be no direct impacts on health or productivity, or specific benefits to the public, beyond ensuring the compatibility of production systems with public moral, ethical, cultural or religious standards. In other cases, there may be associated environmental, biosecurity and public health impacts. To the extent that public policy has defined regulations and welfare codes to give expression to these concerns, then actions that go beyond regulatory requirements may be considered as public goods.

14. Public health: Aspects of public health may be a consequence of individual decisions relating to food purchasing and consumption, but public health can also be influenced by the dominant food and agricultural systems, as well as by regulations and voluntary food standards designed to improve food quality and nutritional value. Public health may be impacted negatively by pollution from agricultural activities (see above) and positively by access to land for recreational benefits, as well as by direct involvement in food production (e.g. allotments, home gardens, Community Supported Agriculture (CSA) initiatives). Some at least of these aspects, for example public access (right to roam) and participation in farm events and activities at below cost to the farmer are often not subject to market mechanisms and regulations and could be considered as public goods.

15. Food supply and security: Currently there is a vigorous debate in the UK about whether food supply should be considered a public benefit, even if it is clearly an ecosystem service. Humans are dependent on food as well as clothing and shelter for health and survival, but these are all usually seen as private goods as they are tradeable commodities (with some exceptions). However, food produced in ways that help to ensure food security for future generations, and/or contribute to providing the other public goods identified here, might be considered as providing public goods at a strategic level, if the practices go beyond those required to meet minimum food quality/safety regulations. There would be a need to avoid double counting if the practices used are themselves also considered to be delivering public goods, as discussed above. In some instances, there would also be a need to consider the opportunity cost of retaining land in food production compared with non-agricultural uses such as nature restoration that might generate greater public goods. Food security, or food sovereignty, in a broader sense, might also be considered a public

benefit to the extent that lack of access to affordable, or indeed any, supplies could lead to civil unrest and damage to social structures, institutions and property. In the UK, the risk of this may be considered low, but it is not absent.

16. Culture: Not always identified as a public benefit from agriculture, there are many instances where farming communities provide the basis for distinctive indigenous societies and rural cultures, often reflected in languages and cultural traditions – Welsh and Gaelic being good examples in the UK. To the extent that farming supports viable rural communities that can help sustain these cultures, this may be considered a public benefit, albeit one outside the environmental domain.

17. Rural vitality: Economic activity, business profitability, employment and incomes are usually considered as consequences of market activity and therefore private goods. However, there are key public policy issues relating to the survival of rural communities, including social structures, the level of access to facilities and the retention of young people. The ability of farm businesses to generate worthwhile employment, incomes and supply that can contribute to maintaining rural vitality and community services can be considered a public benefit, particularly where this offsets efforts to increase labour productivity (e.g. through mechanisation and specialisation), which may be essential to improve (private) profitability.

2.6 Particular issues of relevance to Scotland

The main environmental public benefit issues identified in Section 2.5 are also considered relevant in the Scottish context, subject to the influences of land quality and farm type. While there are specific issues relating to the survival of the Gaelic language and land tenure, including with respect to crofting and larger estates, these are considered to be social/economic issues that go beyond the scope of this study.

Some geographical characteristics of Scotland, such as the large areas of peatland and moorland, with the potential for peat bog restoration, are relevant to the design of any public-benefits-based approach to rural land management. The past history of forestry, future aspirations for afforestation, and ongoing issues with lack of native woodland regeneration due to deer browsing pressures, are also particular to Scotland and distinctive from other parts of the UK. Current Scottish Government woodland planting targets of 10,000 ha/year, increasing to 15,000 ha/year by 2024/25, are having real impacts in parts of Scotland, with large areas being planted up with commercial conifers. Although there is a role for commercial forestry to supply timber and wood pulp, native woodland expansion can result in improved outcomes for biodiversity and deliver substantial carbon sequestration in the short and long term, and without soil disturbance if through natural regeneration. Other options for extending tree cover include hedgerows, agroforestry and nature restoration. The latter could involve a mosaic of habitats, including species-rich grasslands, peatlands and heathlands, scrub areas and native woodlands. Regional and local variations are also important. These have been considered in the study.

2.7 Conclusion

The focus of this study is on environmental public goods, and in particular those factors that farmers can influence. For this reason, the social public goods (13-17) outlined in Section 2.5 are not a focus for the evaluation of options in later stages of the project. Of the environmental ones, it was agreed with the Steering Group that Climate change mitigation, Farmland biodiversity, Soil health and organic matter, Water quality and Public access should be the primary focus for the options to be evaluated in the study. The other environmental benefits may also be addressed to varying degrees by the policy options to be analysed (see Chapter 3).

3. OPTIONS FOR ANALYSIS

This chapter outlines a preliminary list of specific options for using public funds to pay for land managers to improve their delivery of public goods on agricultural land in Scotland. The options are intended to contribute to the delivery of a wide range of environmental public goods identified in Chapter 2, some at a relatively broad scale, covering a significant number of farms, and others in a more targeted way, focusing on particular areas, habitats, species or particular types of farms. Both approaches are required. Most options will contribute, to differing degrees, to the delivery of several public goods. Some options are intended to enable farmers to reduce the negative externalities of their production systems while several are designed to reward (or enable) the provision of public goods that are currently under-provided. In this context, the reduction of certain specified negative externalities, such as forms of diffuse water pollution, below levels required by regulations, is treated as a form of public benefit delivery. The implementation of these options and their potential impacts on farm businesses and environmental outcomes is analysed in subsequent chapters.

As part of the project design, most of the options proposed need to be capable of being adjusted to differing levels of ambition regarding environmental outcomes, since this is not to be determined in advance. As much as possible, they need to be capable of being tailored to the current state of different farming systems, land cover/crop types and regions within Scotland, and be able to provide sufficient continuity with successful existing schemes. In some cases, there should be an explicit option to encourage collective participation by a group of farmers, generally those with land in close proximity, for example within a target catchment. Historically, group participation has not been common practice and it is recognized that this is a weakness when landscape and catchment scale objectives are being pursued. There are some examples of land managers working together in operational groups to improve soils (e.g. cattle moving east to west for winter/summer grazing[19]), and also in some nature restoration projects[20].

In selecting the options, several factors that apply to support schemes in general, and to environmentally-focused schemes in particular, need to be taken into account. These considerations include the need to:

- set sufficiently clear and measurable objectives, for both the responsible public bodies and participating farmers, so that the outcome of the intervention can be assessed, whilst recognizing that long timescales may apply in some cases;
- deliver sufficient value for money, including limiting the risk of deadweight payments, for example by trying to target the uptake to conditions where it is considered most likely to be most effective;
- consider innovative approaches, which might include, for example, more emphasis on rewarding results and/or the introduction of appropriate forms of competition to drive value for money;
- consider the acceptability of long timescales and/or uncertainties regarding the outcome for certain measures. For example, the provision of public goods through improved management of arable soils may incur short-term opportunity costs, but bring long-term benefits to productivity. The delivery of public goods may also be affected by weather or other factors outside the farmers' control. The risks as well as the benefits need to be shared in an appropriate way between farmers and public authorities;
- ensure that a sufficient number of farmers are able to participate and potentially could be recruited to a scheme even if they currently have little engagement with

[19] https://www.innovativefarmers.org/welcometoriss/current-riss-groups/
[20] e.g. Borders Forest Trust www.bordersforesttrust.org

environmental schemes – the reach of the suite of measures has to be sufficiently wide; and

- implement cost-effective verification of compliance with options, to protect public expenditure and the integrity of schemes.

3.1 Some key assumptions

1. The current level of environmental legislation applying to farmland and farming operations in Scotland is broadly maintained and built upon, reflecting greater environmental ambition and the consequences of withdrawal from the CAP. As a first step, it might be reasonable to assume some adjustments similar to the proposed new CAP conditionality (integrating previous cross-compliance and Greening)[21]. This would help ensure both regulatory compliance and a baseline environmental standard on which payments for public goods can be built, alongside a fairer, simpler form of enforcement.

2. The current support system is changed completely, following a transition period ending in 2024. The current Basic Payment Scheme (BPS) and the Pillar I coupled support payments are phased out and replaced by a set of inter-linked schemes focused on the delivery of environmental public goods. The options proposed here would be those in place following the end of the transition. However, some schemes, in particular those with substantial establishment costs, could already be implemented during the transition phase, utilising existing support frameworks where needed. Implementing the new schemes during the transition phase, with participation rates rising as the BPS is phased out, might also make the payment rates look more favourable to farmers during the early transition stage. They would supplement BPS, providing some incentive for early adopters which would be desirable. The environmental ambition of new schemes might change over time, but could be relatively stable during the transition to help the new schemes become familiar.

3. The overall budget for supporting agriculture in Scotland would remain unchanged so that annual expenditure would be at a similar level to now. However, the distribution of support would be significantly different, reflecting the pattern of public benefit delivery on farmland. Expenditure on voluntary schemes would be more difficult to forecast than under the BPS but would become more predictable over time as the new system became established. The balance between annual payments (such as area based payments) and one-off payments (such as capital grants), would not be subject to the same constraints as under the CAP. Investment aid would be likely to increase as a proportion of expenditure, given the focus on the restoration of habitats, including peatland and trees on agricultural land.

4. There would be more support for farmers in the form of information, advice, training and assistance in adjusting to and participating in the new schemes. This would be especially important in the early stages of a new and probably evolving generation of incentives. Enhanced support, information, training and advice would involve increased staffing and public sector resources, but there would be a parallel saving in relation to running current CAP schemes, verifying compliance at farm level and preparing related reports, as well as a potential reduction in deadweight associated with poorly informed/ engaged participants. The net change in expenditure is difficult to forecast.

[21] Lampkin, N., Stolze, M., Meredith, S., de Porras, M., Haller, L. & Mészáros, D. 2020. *Using Eco-schemes in the new CAP: a guide for managing authorities.* IFOAM EU, FIBL and IEEP, Brussels.

5. The payment rates to farmers for individual measures would be sufficient to meet the goals of the scheme concerned, with due regard for value for money and the total sums available. In practice, this could mean that the current income foregone/costs incurred formula was the starting point for estimating the incentive level required, taking account of changing conditions and the removal of Pillar 1 direct payments. However, if this level of payment was not sufficient to attract the target of say X thousand hectares of enrolment, then the level of payment could be raised, recognizing that the incentive was insufficient to meet the costs of entry as farmers perceived them. This would result in higher payments per ha (or other relevant unit) than under many existing schemes. Clearly some farmers might receive more than they do now under the CAP and others less, depending on their capacity and willingness to deliver the relevant environmental public goods. Within this broad frame there might be options in which more novel approaches are adopted, including more results-based payments, e.g. for enhancing floral diversity in grassland (see Annex 2). This would allow more reflection of natural capital values if desired. However, we have not articulated this in detail for modelling purposes.

6. Schemes aimed at farmers would be accompanied by measures to support selective forms of woodland management and the establishment of new woodland in certain areas. The complementary forms of support would need to be developed and delivered in an integrated framework. This aspect of the new policy framework is considered in part in this study, specifically with respect to agroforestry and nature restoration, but not commercial forestry.

3.2 The options

These initial suggestions draw on proposals from several sources, including those from IEEP, from members of the steering group and from published reports such as those from Scottish Environment LINK, the Scottish Wildlife Trust and the Yorkshire Wildlife Trust (see Page 1). The core goals and management requirements are set out below.

The schemes are not presented as a final model and do not consider future delivery mechanisms. More data, expertise and stakeholder input will be needed to build actual schemes. They do, however, illustrate alternative options to deliver environmental benefits more effectively, with the consequences assessed using relatively simplified assumptions via modelling and case study farms.

3.2.1 Environmental maintenance and improvement scheme

This entry-level, individual farm focused scheme would require a variety of actions that build on top of legal and minimum environmental standard (conditionality) requirements to offer a range of environmental public goods, including improved landscape and habitat management, improved soil and water management, reduced emissions to air (including for ammonia and GHGs), reduced pesticide use and more integrated pest management, improved nutrient management, improved and more connected field margins, and enhanced public access.

More targeted and specific schemes, as well as co-operative activities between farms, would build on top of this. It would be designed so that nearly all farms could participate at some level, but would require commitments going beyond current GAECs or conditionality (see Section 3.1-1). Selected elements of Greening, including ecological focus areas from a more restricted list of options, could qualify for payment. Enrolment would be for a fixed period, e.g. 5 years.

The approach would require a broad suite of options to capture different environmental benefits and farming conditions. Payment could be by a points system, with a certain number

of points required to qualify for a reduced payment and a larger number required for the full payment. Certain options could be mandatory for farms wishing to participate. There could be regional targeting by means of adjusting the points awarded for a particular activity and by varying those measures that are mandatory. However, a fairly simple approach is sketched here. The key elements would be:

a. an environmental assessment and improvement plan, including nutrient and other resource management, undertaken by an accredited environmental advisor and reviewed after 4/5 years – this could include a sustainability assessment using suitable (i.e. approved by a relevant agency) tools;
b. compliance with the minimum GAEC/conditionality requirements as a pre-requisite, with the main focus on the maintenance of environmental values;
c. a commitment to reach certain standards of management and enrichment of hedges, walls, clumps of trees, ponds, small habitats and landscape features – this may involve significant improvement as well as maintenance in some cases, but management would be key;
d. maintaining 6 metre uncropped field margins, beetle banks and buffer strips along watercourses and other features (12–24m for wider watercourses and against still water features);
e. at least 5-10% of the farmed area accounted for by features in categories c. and d. above;
f. maintaining more diversity on cropping farms, including crop diversity, balancing spring and autumn sowing, grass/legume breaks for soil restoration, green manures, cover crops and fallow to score the maximum points in certain areas. However, there may be some overlap with Option 3.2.2;
g. adopting more holistic management to retain and enhance soil conditions/health – a soil organic matter balance calculation could be included alongside field management;
h. meeting certain standards of nutrient management, including accepting a ceiling on nitrogen inputs or on budgeted nitrogen surpluses – this could be extended to include specific consideration of nitrate leaching, ammonia and GHG emissions;
i. taking defined steps towards pesticide use reduction, including integrated pest management (IPM), reduced use of pre-harvest desiccants, and phasing out certain legal products;
j. achieving more sward diversity through a certain percentage of legumes or other approved plants in improved grassland;
k. ensuring total farm livestock numbers are compatible with limiting nutrient surpluses and sustainable levels of grazing, reflecting specific local conditions;
l. awarding additional points for joining collective schemes, larger reductions in input use, more diverse swards, more diverse rotations and special measures for pollinators, sacrificial areas for birds, features and management changes creating larger scale connectivity etc.; and
m. supporting public access, with a focus on the creation of new routes (currently delivered through the Improving Public Access scheme part of the Agri-Environment Climate Scheme (AECS)) beyond land access legislation.

Exact thresholds and corresponding payments would reflect the level of ambition and potentially could change over time. There would be core themes within the optional menus to help pursue a coherent approach. These can be illustrated briefly.

- Improved arable soil and water management would be a key theme for more intensive arable areas, alongside the enhanced management and enrichment of landscape features, which would be mandatory for all participants. This would require the uptake of certain management options, including buffer strips and IPM, and a reduction in fertiliser and pesticide inputs, to reduce diffuse pollution, compaction and erosion risks, and to enhance infiltration. The aim would be to attract farmers from a wide spectrum

and not via regional targeting, in order to improve soil management, reduce nitrogen inputs and manage soil carbon to maintain/reach desirable equilibrium levels in arable soils across Scotland.

- On predominantly grassland farms in the lowlands, including many dairy farms, nutrient budgeting, more diverse swards including legumes, and improved soil and water management would be key themes alongside the enhanced management and enrichment of landscape/habitat features. Aims would include reductions in poaching and over-grazing, build-up of soil carbon and long-term carbon sequestration, reduced nitrogen and pesticide use, reduced water pollution, improved manure and slurry management and accompanying enhancement of biodiversity. Some regional targeting of biodiversity measures would be desirable, e.g. in hotspots, even in an entry-level scheme. Specific prescriptions could vary depending on the level of environmental ambition and the breadth of participation aimed at. It would be possible to aim at relatively widespread participation on lowland dairy farms. Again, there could be enhanced payments for group participation in certain circumstances. Aid for capital investment in improved slurry management above basic legal requirements would complement this scheme (6 months' storage is both a GAEC and NVZ requirement).
- On upland farms and crofts with predominantly rough grazing, the prescriptions would be relatively simple, given the already low levels of input use and lack of opportunities for crop diversification and grassland improvement. They would include the management and enhancement of landscape/habitat features and the respect of appropriate stocking rates.

For the purposes of modelling and subsequent analysis, we have represented this option by:

- uncropped field margins and ecological focus areas, representing 5 or 10% of the farm's agricultural area excluding rough grazing;
- reduced input use on the cropped land, with 10% and 20% reductions assumed while maintaining productivity; and
- combinations of uncropped margins and input use reduction on cropped land.

As the public access option is most likely to be relevant to farms close to urban areas, making a general financial assessment by farm type less appropriate, this was not modelled specifically.

3.2.2 Multi-functional, agro-ecological farming systems scheme

Multi-functional, agro-ecological farming systems combining a variety of practices generating several different public goods represent an alternative option to prescriptive schemes[22]. They could build on existing schemes, such as for organic conversion and management, and would cover either the whole or part of the farm. They would include some, but not necessarily all, of the practices identified in the environmental maintenance scheme (Section 3.2.1), but would most likely be implemented as an alternative to rather than in combination with that option. However, some basic rules might be shared by the more generic approach outlined above in 3.2.1 and by these system-focussed schemes. Four specific systems are identified here but this list could be adapted:

- Conservation agriculture/Integrated Pest Management on arable farms. Conservation agriculture is focused on a) zero tillage, b) extended rotation and c) the use of green manures/cover crops. It has no specific constraints on the use of agrochemical inputs, but does generate benefits in terms of soil health and potentially carbon sequestration

[22] *Op cit.* (17, 21)

with minimal impacts on yields. Combined with IPM, which emphasises the integration of biological control, habitat management and crop management practices to reduce pesticide use[23], a wider range of biodiversity benefits are achievable. The benefits can further be enhanced through an IPM+ approach imposing further constraints on agrochemical inputs, but with greater yield reductions involved. Unlike organic farming, there is no legal certification scheme for validation, but appropriate conditions could be specified. Support could be provided on a similar basis to organic farming, but at lower rates.

- Organic farming. Organic farming involves restrictions on almost all agrochemical inputs, in particular nitrogen fertilisers and pesticides, with demonstrated benefits for soil health, water quality, biodiversity and climate change mitigation, but with greater impacts in terms of yield reductions. It is legally defined at EU level, and some form of legal regulation is expected to be implemented in the UK post-Brexit. The approach is applicable across all farm types, although market opportunities are greatest in the arable, horticulture and dairy sectors. Particularly in the absence of premium prices, or if premium prices are recognised more as remuneration for marketing activities rather than environmental land management, the greater public goods and reduced output would imply higher payment rates than say for conservation agriculture.

- High nature value (HNV) farming and crofting. HNV farming involves preserving and enhancing traditional, low-input systems, often involving extensively managed grazing livestock. Here there is a mix of social as well as environmental objectives, where maintaining existing environmental public goods may be the main priority. The options would focus on maintaining viability and promotion of more diverse mixed farming systems in crofting areas. The specific environmental benefits may be quite localised, so that the 'practice bundle' to be supported could vary significantly from farm to farm, potentially including results-based approaches (Annex 2).

- Approved agroforestry systems. Integrating trees and shrubs with crops and livestock production can generate multiple public goods, including improved soil management, carbon sequestration and biodiversity conservation, as well as animal welfare and co-benefits for the farmer. Agroforestry can take different forms, including grazed woodlands, wood pastures, shelter belts, parkland with scattered individual trees, orchards, alley cropping, riparian woodlands and hedge boundaries[24]. This option is not necessarily a whole-farm approach, but would suit parts of holdings in most cases. Indigenous species could be prioritised where relevant[25].

In the modelling exercise, inevitably simplifying the requirements, we have assumed that:

- Conservation agriculture is represented by zero tillage, use of cover crops and 1/6th of the rotation as grain legumes, with no adjustments made to agrochemical use.
- Organic farming involves production to current organic regulations limiting inputs, with reduced yields and higher prices[26]. Stocking rates on grassland are assumed to be reduced by 20% compared with non-organic. On arable farms, grass/clover leys (rotational grassland) would replace some combinable crops, with increased overall livestock numbers only in this specific context.
- HNV farming systems are less amenable to the modelling approach used, due to the variability in practices involved and have therefore not been modelled directly. The

[23] EU Directive on Sustainable Use of Pesticides 2009/128/EC
[24] Raskin, B. & Osborn, S. 2019. The Agroforestry Handbook. Soil Association, Bristol. https://www.soilassociation.org/farmers-growers/technicalinformation/agroforestry-handbook/
[25] NatureScot Trees and shrubs native to Scotland.
[26] Lampkin, N., Measures, M. & Padel, S. (eds.) 2017. 2017 Organic Farm Management Handbook. 11th edition. Organic Research Centre, Newbury.

case studies for hill sheep farming and crofting are most relevant in this context, with the environmental maintenance and habitat conservation options also relevant.

- Agroforestry (integrating trees with crops and/or livestock) takes different forms for different farm types, with 5 or 10% of agricultural land taken by trees:
    - alley cropping with apple trees on arable farms, <100 trees per whole field ha, with 3m wide tree rows at 24m intervals occupying ca. 10% of land;
    - hedgerows including trees on dairy farms, planted at 4 trees/m (400/ha), with potential for woodchip harvesting;
    - scattered individual trees (50/ha) on improved permanent grassland in lowland cattle and sheep farms;
    - shelter belts on rough grazing land on hill sheep farms, with mixed native conifer and broadleaf species appropriate for land classification (e.g. scots pine and birch) – planting density for shelterbelt 2500 trees/ha, overall density including rough grazing depends on frequency of shelter belts; and
    - wood pasture on improved land on crofts, planted at 200 trees/ha initially, reduced to 100 trees/ha following thinning.

  (Further information on the tree densities assumed can be found in the Agroforestry Handbook[27].)

3.2.3 Environmental enhancement through habitat conservation and nature restoration schemes

This is a more demanding and targeted scheme, based on specified commitments attracting their own payments over time periods that may differ in length (e.g. extending to 10 years), rather than a fixed payment reflecting qualifying points. Some elements would be paid according to the results achieved (e.g. number of higher plants on a locally appropriate list) and results-based approaches (see Annex 2) would be expanded over time. Progress would depend to some degree on the availability of appropriate indicators of results that were reliable and fit for purpose. However, there could be options based on a more conventional model of following an agreed prescription, especially in the early years. Each situation is likely to be unique, which might open up different approaches to agreeing payments, including public contracting/tendering approaches.

Targeting would be both geographical and by environmental theme, e.g. habitat restoration or flood management. It would have a distinctive regional character and draw on the Scottish Land Use strategy and the regional land use partnerships.

Many of the agri-environment-climate options in the existing rural development programme could be fine-tuned, upgraded with higher payment rates in most cases and included in this much enlarged scheme. This would be the leading driver of public goods delivery and could potentially have around half or more of the overall budget for agricultural land management in Scotland.

Many options would benefit from the participation of a group of farms in a particular geographical relationship, for example within a priority catchment or landscape requiring large scale change in management. Where this was identified as a priority locally, there would be a premium for farmers joining a group, say a 10-15% supplement, which might decline over time if the response rate was high.

3.2.3.1 Habitat conservation

Core themes would include the conservation and restoration of selected habitats and species, the restoration of pollinators, re-establishment of native woodland, enhancement of HNV

[27] *Op cit.* (24)

grassland, the incorporation of more fallow and dedicated biodiversity areas (including mid-field strips and sacrificial cereal crops for birds) in arable systems, restoration of flood plains and natural flood management, and new approaches to low input use. There would be a separate sub-scheme focused on peatland restoration because of its special character and importance (see below). Individual species management and recovery schemes (e.g. for waders) would be included and tied to specific objectives where possible.

Biodiversity enhancement and recovery would be the largest element of the overall scheme. On more productive, intensively managed farms, this would require a certain proportion of all the land on the farm to be managed for wildlife enhancement, say 15% or more, depending on the level of ambition, including boundaries, in-field strips, diverse swards and pollinator zones – all involving significant departures from standard commercial farm practice. Low or very low stocking densities would be required on most grazed land within such schemes depending on the location and management aims, along with rules on mowing dates and additional incentives for demanding requirements, such as the re-introduction of hay meadows. On upland and island HNV farmland, predominantly managed by grazing livestock, support for low stocking densities and appropriate smaller scale cropping would be required.

The water management segment could be targeted primarily to sensitive catchments but some of these would benefit from other measures as well, including peatland restoration, regeneration of native woodland and promotion of organic farming. Strict limits on nutrient and agrochemical use, appropriate storage and management of manure would apply where required and depending on ambition levels.

Detailed prescriptions and sufficient rates of payment are difficult to specify as they would vary considerably and take up would be subject to precise targeting. To achieve results in the absence of the BPS, payments would need to be considerably higher than at present to ensure sufficient take-up, again depending on the level of ambition. Higher payments in the uplands, islands and remote areas on livestock grazing land prioritized for its HNV attributes would be essential given its high dependence on direct and agri-environment payments at present. Investment aid would be available for environmental restoration work and to help secure the viability of certain farms (e.g. marginal HNV producers) on a selective basis.

3.2.3.2 Peatland management/restoration

This would be designed to restore peatland habitats and enhance carbon sequestration, substantially accelerating recent progress in this direction under AECS and the Peatland ACTION project. Re-wetting would be a key requirement of an agreed management plan in most cases. In certain locations, the removal of trees and restoration of more natural vegetation would be necessary. Some land would need to be removed from any long-term agricultural management, but in other cases it could be retained under certain conditions, with grazing at very low densities for example. There may also be sites where the introduction of paludiculture[28] would be worthwhile and would provide an income for those undertaking appropriate management. The annual management payment would need to be about the same level or higher than in recent schemes, depending on the level required to meet the target. This option would include enhanced payments for sub-catchment implementation by groups of land managers. For farmers, the obligation would be to follow a dedicated management plan, generally involving:

[28] Paludiculture is the productive use of wet peatlands for agriculture and forestry. It includes traditional peatland cultivation (e.g. reed mowing) and new approaches for utilisation, with the preservation of peat as a main objective. While the above ground biomass is harvested, the underground biomass accumulates and new peat formation may take place.
https://www.moorwissen.de/en/paludikultur/paludikultur.php
See also: http://publications.naturalengland.org.uk/publication/5411482582122496

- extensive capital works to raise water levels, including drain blocking;
- agreeing not to undertake a range of agricultural activities, including pesticide use, excessive stock grazing, building tracks, over grazing and planting trees;
- agreeing to follow certain practices, which might include grazing;
- not planting trees on peatland; and
- monitoring the condition of the bog and preparing an annual report.

The Scottish Government has a target of restoring 250,000 ha of degraded peatland by 2030, implying an annual average of close to 25,000 ha per annum in the years after 2020. A scheme would aim to reach this level and pace of restoration and would require enhanced funding, complementing the ongoing Peatland Action project[29].

Restoration costs in recent years are averaging around £1,000/ha and involve a mixture of capital works and annual management payments. As more challenging restoration projects are tackled, this cost is expected to rise. This option was not modelled directly – further work would be required on accurately costing this scheme, given the lack of contractors and the investments in specialist machinery required.

3.2.3.3 Large-scale nature restoration

There are now a number of interesting pioneer projects of this type, which are demonstrating the potential of large-scale nature restoration schemes to support biodiversity and carbon sequestration. One example in an upland context is Carrifran Wildwood developed by the Borders Forest Trust[30]. Over half a million trees were planted in the lower valley areas, with other shrubs and trees in the higher areas to recreate montane scrub and a natural treeline. Sheep and goats have been fenced out, and roe deer culled, to allow natural regeneration. The project now covers nearly 3000 ha. Another is the Cairngorms Connect[31] partnership, where neighbouring land managers are working to restore an area of over 600 km^2. Although an English example, the 1400 ha Knepp Estate[32] experience is also relevant, due to the integration of cattle and pigs as part of the nature restoration. In all cases, there is good evidence of birds and other species returning to the areas. Key to these examples is enabling natural processes to restore degraded ecosystems and landscapes, rather than following individual-species-focused management prescriptions. This can be supported for example by deer control, removal of non-native species, actions such as blocking drainage that prevent natural processes and allowing water to flood naturally over areas of land.

The aim of this option would be to secure an ambitious improvement in the type and scale of wildlife habitat provision, which could include species-rich grasslands, peatland restoration, other wetlands, scrub and woodlands, catchment protection and group initiatives. The expectation would be that the land involved would be largely if not entirely removed from agricultural production, with conservation grazing included where appropriate.

[29] https://www.nature.scot/peatland-action-outcomes-and-eligibility-2019-2020
[30] *Op cit.* (20)
[31] http://cairngormsconnect.org.uk/
[32] www.knepp.co.uk

For the analysis, we have assumed two simplified versions of the above:

a) 20% of farmland allocated to habitat conservation as described in Section 3.2.3.1;[33]
b) 50% of farmland allocated to nature restoration as described in Section 3.2.3.3

Because of the larger scale of land removal from agriculture in each case, these options were not amenable to modelling using the same approach as for 3.2.1 and 3.2.2. Instead we utilised the baseline model data and estimated the impacts of taking specific areas of land out of production, including impacts on livestock numbers and margins. In the case of 50% nature restoration, we also assumed that there would be a reduction in fixed costs resulting from the changes. As described above, no attempt was made to estimate the peatland restoration example, although it is relevant in this context.

3.2.4 Supplementary pathfinder scheme

This is a different but complementary approach also outside the modelling exercise. It would provide payments for defined ecosystem services delivered mainly by groups of farmers. The concept is to create a stream of income, from private rather than public sector sources, for those farmers able to deliver defined services within new contractual arrangements. The public sector element would be the costs of helping to get an initial series of contractual schemes off the ground, meeting certain categories of expenditure, such as specialist advice, legal expenses, small pilots, fees for a facilitator and establishment of monitoring regimes, once key conditions were in place.

Three options are outlined here as the initial focus of such a scheme:

1. Improving water quality in selected catchments where there is a pollution load, for example of nutrients clearly stemming from agricultural practices that could be modified, and there is also a current requirement to undertake water treatment to meet public supply standards. The cost of water treatment could be avoided by improved land management, for example by fewer/differently managed stock and fertiliser/pesticide applications on farms within the catchment. Payments to change farmland management would be worthwhile for the body responsible for supplying clean water. However, to be viable an incentive scheme would require sufficient participation by farmers in the right locations who were currently contributing to the pollution load. Pilot measures and support to establish the right conditions may be necessary[34].

2. Contributing to flood management in certain catchments where changes in land management would reduce the speed of run-off and the regularity and intensity of flood events downstream. Investment in costly flood defences might be avoidable if a robust land management scheme could be established and the farmers with the requisite land and capacity to manage it appropriately could be recruited. Technical measures could include the removal of some field drainage and the introduction of natural flood management measures, such as the creation of new flood meadows. Group participation and site-specific undertakings would be essential.

[33] While there may be existing habitats on farms, these will be specific to individual situations, so the modelling was not able to account directly for pre-existing habitats and the focus was on new areas. However, the baseline agri-environment payments recorded will reflect in part at least participation in options to protect pre-existing habitats.

[34] Green Alliance. 2017. *Natural infrastructure schemes in practice: how to create new markets for ecosystem services from land*. Green Alliance. London, and PEGASUS project case studies in France http://pegasus.ieep.eu/case-studies/introduction

3. Tradeable carbon quotas to encourage farm-level sequestration on a significant scale. This could include sequestration in soil and vegetation, subject to suitable long –term commitment. This is not yet a developed market, so the potential would need to be tested and realistic markets for carbon credits identified, along with the development of robust verification processes.

In each case there would need to be a beneficiary of the service who has an incentive to buy this from land managers and therefore avoid the need for public payments. This might also apply where developers are needing to offset impacts of their own activities elsewhere. The markets that exist for tree planting through the Woodland Carbon Code need to be further developed, practical and institutional issues resolved, drawbacks identified, and the appetite of the different players tested. A pathfinder scheme would involve public funding for one or more of these options, with public money deployed in this first stage where needed.

This scheme would effectively be a pilot and is not yet sufficiently delineated to be able to model in the main phase of the project. It is noted as an element that may be developed further within a public-benefits-focused agricultural policy.

3.2.5 Accompanying measures

Measures to complement the support schemes would be required. These can be summarised as:

- investment support to enable delivery of public benefit outcomes, including in soft infrastructure, new equipment (e.g. to facilitate better soil and nutrient management), appropriate buildings, including for livestock. This would be attached to most of the options.
- the use of farm sustainability tools to support decision making and prioritise interventions as well as monitor outcomes (see Chapter 5) and
- targeted advisory and skills support at farm level, assumed to be at no cost to the farmer, as discussed above.

4. FARM TYPE DESCRIPTIONS AND CHARACTERISTICS

4.1 Introduction

The options have been evaluated based on five main farm types: arable, dairy, lowland livestock, hill sheep and crofting. These have been used as a basis for case studies, using both representative statistical (Farm Structure Survey, FSS) and financial (Farm Business Survey, FBS) data for these types. In addition, a case study farm was selected for each farm type to enable the options to be validated in terms of relevance, strengths and weaknesses in an individual farm context. For crofting, two case study farms were used, due to the lack of relevant statistical data to define a representative farm. The case study farmers requested anonymity, which has been respected in the report. The individual farm studies were carried out by SAC agricultural consultants.

In the analysis and figures illustrating the different farm types and options, woodlands and other non-agricultural land uses have been excluded, on the basis that the woodlands were more likely to be commercial forestry and less relevant to the agricultural use of the land. This may not always be the case in practice, for example where native woodlands are integrated with rough grazing or other land. Attention is drawn to this where relevant.

4.2 Arable

4.2.1 General description of farm type

Cropping farms (specialist cereals, horticulture and general cropping) accounted for nearly 4,900 holdings and 538 kha, or 8.5% of Scottish agriculture, in 2017. The average farm size of these farms is about 110 ha. Just over half the area (272 kha) on these farms is cropped with cereals, of which spring barley (136 kha) and wheat (83 kha) are most important. Oilseed rape, potatoes and other root crops are grown to a lesser extent, with soft fruit and vegetables grown mainly in Tayside and Fife. Rotational and permanent grass occupy 87 kha, or 16% of the land, in these farm types. The most common livestock utilising this land are beef cattle (57 khd) and sheep (115 khd). Figure 4.1 illustrates the typical land use pattern for general cropping farms.

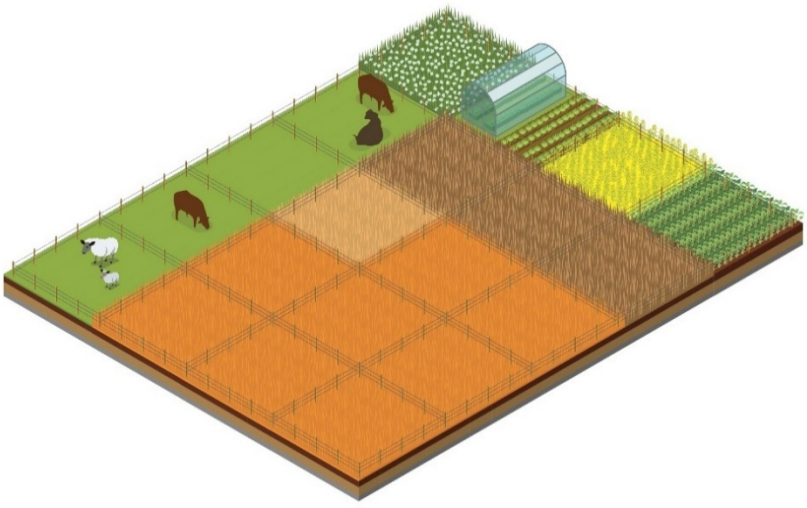

Figure 4.1: Schematic illustration of general cropping farm type

Source: Scottish Government Farm Structure and Farm Business Survey Statistics. Key: see Annex 1

4.2.2 FBS results for farm type

According to Scottish FBS results (Table 4.1), the share of farm business income (FBI) derived from agriculture on cereal and general cropping farms is low or negative (horticulture is not reported in Scotland). It should be noted that average farm size is higher in FBS than FSS samples, due to the exclusion of smaller holdings. Other activities and direct payments together account for most if not more than the total FBI. Agri-environment payments are very low on average, indicating low overall rates of participation, even if individual farmers may be more actively engaged. Improving efficiency to reduce input costs, exploring specialist markets for a more diverse range of crops or organic products, and increasing agri-environmental activities, could provide opportunities for improving financial prospects in the face of a likely fall in basic income support. Arable farmers tend to engage more with entry-level options such as uncropped field margins and less with habitat conservation and other higher-level options, which may in part explain the low average payments per hectare.

Table 4.1: Farm business survey results for specialist cereal and general cropping farms, 2017/18

	Agri-culture	***Direct payments***	***Agri-env'ment***	***Other***	***Total***
Specialist cereal farms					161 ha
Total output (£/ha)	1,043	209	2	213	1,466
Total costs (£/ha)	1,140	0	0	107	1,247
Farm bus. income (£/ha)	-97	208	2	106	219
Total output (£/farm)	167,879	33,578	311	34,301	236,069
Total costs (£/farm)	183,538	42	22	17,227	200,829
Farm bus. income (£/farm)	-15,659	33,536	289	17,074	35,240
General cropping farms					188 ha
Total output (£/ha)	1,748	199	2	142	2,091
Total costs (£/ha)	1,664	0	0	75	1,739
Farm bus. income (£/ha)	84	198	2	67	352
Total output (£/farm)	328,631	37,363	466	26,609	393,068
Total costs (£/farm)	312,780	82	37	14,081	326,980
Farm bus. income (£/farm)	15,850	37,281	429	12,528	66,088

Source: Farm Business Survey, Scotland.

4.2.3 Case study farm A description

Farm A is a 164 ha arable farm in Morayshire, producing spring barley, winter wheat, and contract growing carrots on additional rented land, with hedges surrounding most fields (illustrated schematically in Figure 4.2). A small amount of grassland is contract grazed and cut for silage sold off farm. The farm is run within the family, with one full-time and one part-time worker. The farm is not currently part of AECS, but has previously been a part of the Rural Stewardship Scheme and still receives some residual agri-environment funding for hedge management. While interested in exploring options within AECS, it was felt that they would not score enough points to be eligible, based on what they were able to do on the farm.

Farms in the area are predominantly mixed farms, with very few purely arable farms, and include a range of sizes. Morayshire is the last sheltered land suitable for arable up the east coast, buffered from higher rainfall in the west and north by the Highland mountains. It is one of the driest areas in the East of Scotland with an average rainfall of less than 600mm.

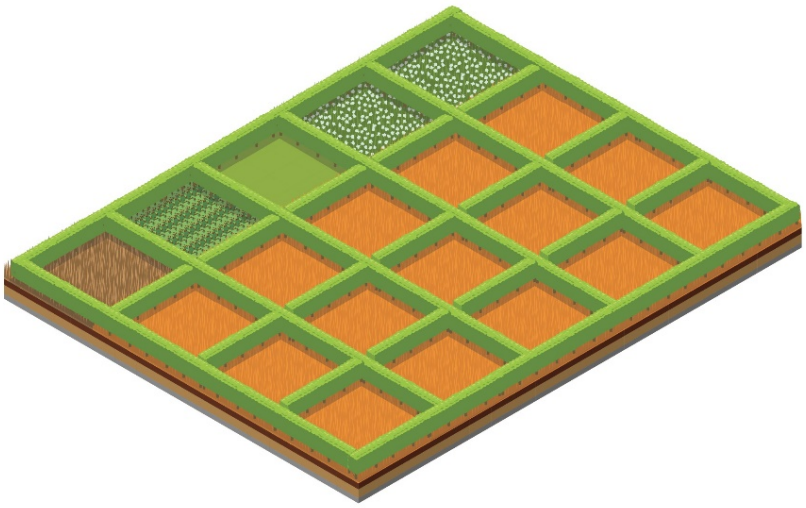

Figure 4.2: Schematic illustration of case study cropping farm A.

Source: modified farm data. Key: see Annex 1

4.3 Dairy

4.3.1 General description of farm type

659 farms on 98 kha agricultural land area (about 149 ha/farm) are classified as dairy in Scotland, representing 1.5% of total agricultural land use. These are mainly grassland farms: 82.5 kha or 84% of the total agricultural area is grassland (rotational grazing 19%, permanent grass 59% and rough grazing 6%). Tillage accounts for about 12 kha, of which 10 kha are cereals (about one third wheat and two thirds barley). This is illustrated schematically in Figure 4.3.

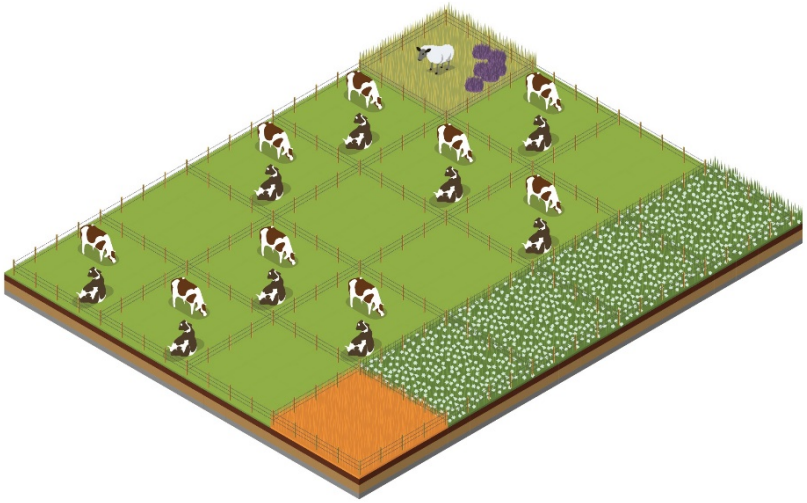

Figure 4.3: Schematic illustration of dairy farm type

Source: Scottish Government Farm Structure and Farm Business Survey Statistics. Key: see Annex 1

4.3.2 FBS results for farm type

Dairy farmers generate more income per ha from agricultural activities and from agri-environment schemes *on average* than cropping farms, with a lower proportion of farm business income derived from direct payments and from other sources such as contracting (Table 4.2). Dairy farmers tend to be more involved with agri-environmental capital

investments such as slurry stores, farm tracks and hard standings, which may not be fully reflected in the FBS average values for AECS income.

Table 4.2: Farm business survey results for dairy farms, 2017/18

	Agri-culture	***Direct payments***	***Agri-env'ment***	***Other***	***Total***
Dairy farms					170 ha
Total output (£/ha)	3,085	211	22	76	3,394
Total costs (£/ha)	2,907	0	0	56	2,964
Farm bus. income (£/ha)	178	211	22	20	430
Total output (£/farm)	524,369	35,903	3,800	12,918	576,990
Total costs (£/farm)	494,157	54	38	9,597	503,846
Farm bus. income (£/farm)	30,213	35,849	3,762	3,321	73,144

Source: Farm Business Survey, Scotland.

4.3.3 Farm D description

Farm D is a dairy farm in Ayrshire is 159 ha with approximately 140 ha of permanent grassland and 19 ha of rotational land including cropping. The business also has a 12ha woodland component (not illustrated). The farm milks a herd of around 180 traditional Holstein/Friesian cows, selling young bulls and heifers that are not retained as replacements. The farm is family run with two full-time workers. The farm does not receive an agri-environment payment. They were previously participants in the Climate Change Focus Farm project and are very focused on progressive, sustainable and efficient farming.

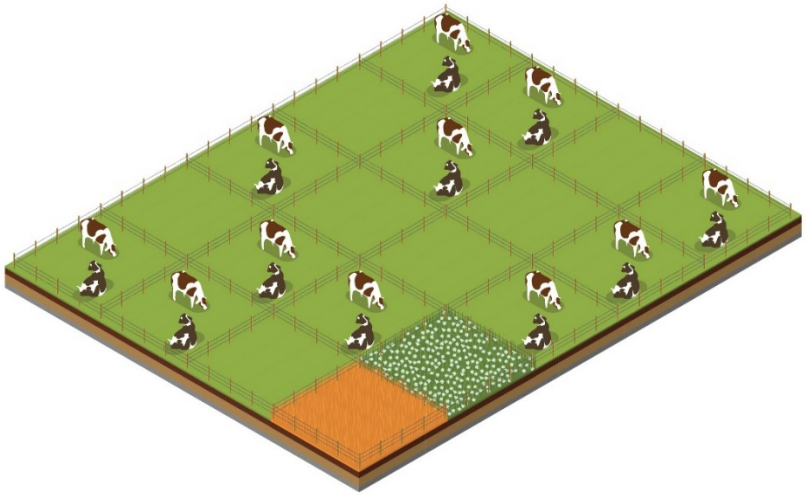

Figure 4.4: Schematic illustration of case study dairy farm D.

Source: modified farm data. Key: see Annex 1

Farming in Ayrshire is predominantly dairying, with most Ayrshire dairy farms concentrated around Kilmarnock, Ayr and east towards Lanark. While there are some larger herds, the average herd size is close to 200 milking cows. Small numbers of dairy farms exist to the north and south in Ayrshire, but these areas are more commonly used for mixed farms, and beef and sheep systems are more prevalent. While some large arable units do exist, particularly towards Girvan in the south, much of the land is best suited to grass, although it is not uncommon for farms to have a small arable component.

4.4 Lowland livestock

4.4.1 General description of farm type

Lowland livestock farms can be represented in statistical terms by the robust farm types lowland cattle and sheep (non-LFA grazing) and mixed, with the latter having a greater arable component. Specialist pig and poultry units are not included in this category. Together these two types account for 417 kha agricultural land (6.6% of Scottish UAA) on 7,294 holdings (on average 57 ha/farm). Grassland accounts for 57% of the land use (rotational grass 14%, permanent grass 32%, rough grazing 11%). Cereals account for 26% of land use (wheat 4%, barley 20%). Some potatoes are also grown on mixed farms.

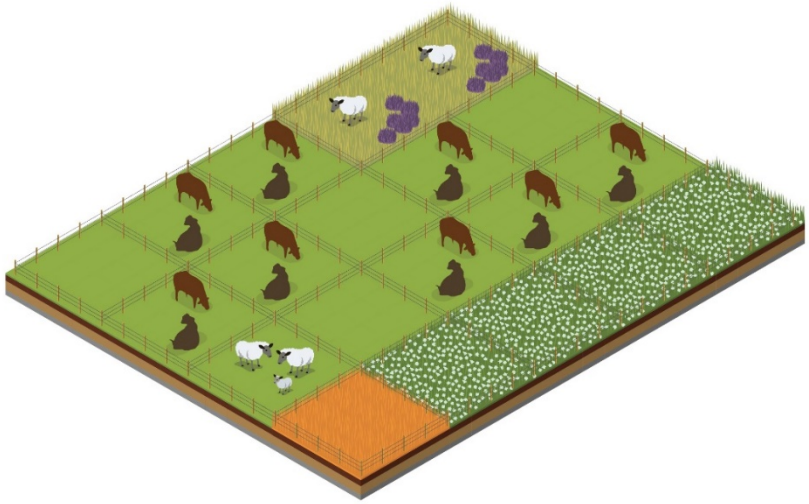

Figure 4.5: Schematic illustration of lowland cattle and sheep farm type

Source: Scottish Government Farm Structure and Farm Business Survey Statistics. Key: see Annex 1

4.4.2 FBS results for farm type

On average, both farm types make a loss on agricultural activities, offset to an extent by other enterprises including contracting. They are very reliant on the basic payment, with total farm business income less than the value of the basic payment received in both cases. They typically have modest income from agri-environment activities (£2,000-£2,500 per farm annually, less than dairy farms but more than cropping farms).

Table 4.3: Farm business survey results for lowland cattle/sheep and mixed farms, 2017/18

	Agri-culture	***Direct payments***	***Agri-env'ment***	***Other***	***Total***
Lowland cattle/sheep					135 ha
Total output (£/ha)	1,038	248	19	52	1,358
Total costs (£/ha)	1,089	1	0	33	1,123
Farm bus. income (£/ha)	-52	248	19	20	235
Total output (£/farm)	140,107	33,546	2,618	7,084	183,354
Total costs (£/farm)	147,082	117	9	4,402	151,609
Farm bus. income (£/farm)	-6,975	33,429	2,609	2,682	31,745
Mixed farms					150 ha
Total output (£/ha)	1,080	239	13	174	1,505
Total costs (£/ha)	1215	1	0	96	1312
Farm bus. income (£/ha)	-135	238	13	78	194
Total output (£/farm)	161,963	35,906	1,923	26,027	225,818
Total costs (£/farm)	182,213	149	37	14,367	196,766
Farm bus. income (£/farm)	-20,251	35,757	1,886	11,660	29,052

Source: Farm Business Survey, Scotland.

4.4.3 Farm L description

Farm L is a lowland mixed farm in Aberdeenshire, with around 40 ha of permanent grazing (largely improved pasture with a small amount of rough grazing), as well as 40 ha of temporary grazing within the arable rotation. The farm also has 20 ha of commercial forestry and shelter belts (not shown in Figure 4.6). They have around 180 head of beef cattle, 150 breeding ewes, and grow around 30 ha of barley, of which just a small amount is fed to stock. Fodder crops are also grown. The farm is family run with two full-time workers. They participate in agri-environment, young farmer top-up and beef calf schemes.

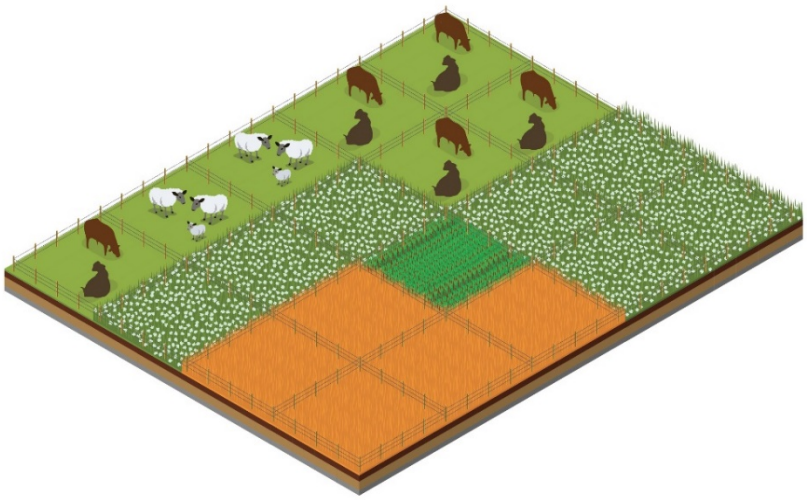

Figure 4.6: Schematic illustration of case study livestock farm L

Source: modified farm data. Key: see Annex 1

Aberdeenshire has a distinctive mix of farming systems and enterprise types, with some of the UK's most northern good quality arable land. It is also an important area for beef production, with a high concentration of livestock and crops most typical of Scotland. Mixed farming is therefore quite common, and the farm selected represents a fairly typical farm in the area.

4.5 Hill sheep

4.5.1 General description of farm type

The Scottish hills and uplands are characterised as less favoured areas (LFA), and for these there are three robust farm types defined: specialist sheep, specialist cattle, and cattle and sheep. For the farm structure survey data, these are grouped together as LFA grazing. For this group, 15,000 holdings cover 3.1 million ha of agricultural land (50% of Scottish UAA and 211 ha/farm on average). Grassland accounts for almost 90% of the agricultural land area (rotational grass 2.5%, permanent grass 21% and rough grazing 60%). A small area of cereals is grown, mostly spring barley. Forestry is a significant other activity (not illustrated in the Figures in this report).

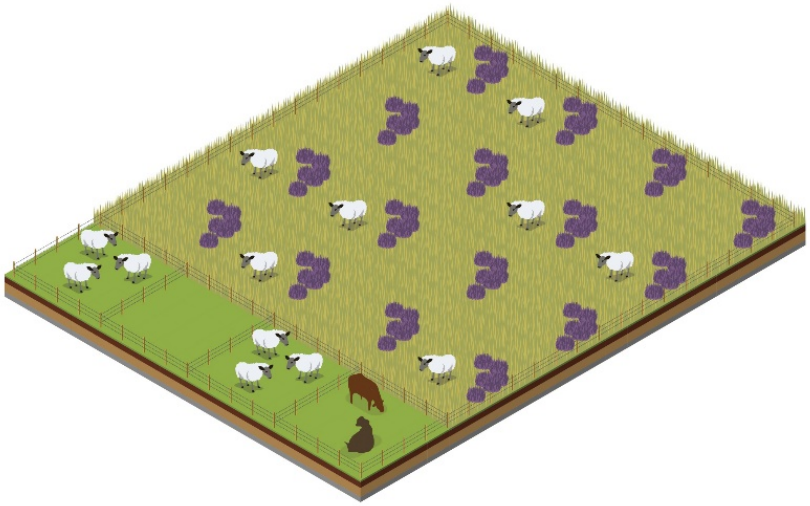

Figure 4.7: Schematic illustration of LFA grazing farm type

Source: Scottish Government Farm Structure and Farm Business Survey Statistics. Key: see Annex 1

4.5.2 FBS results for farm type

On average, all three farm types make a loss on agricultural activities, offset to an extent by other enterprises including contracting. As with lowland livestock and mixed farms, they are very reliant on the basic payment, with total farm business income less than the value of the basic payment received in all cases. However, these farm types typically have the strongest engagement with agri-environment activities (£7,500-£14,000 per farm annually).

Table 4.4: Farm business survey results for less favoured area (LFA) farm types, 2017/18

	Agri-culture	***Direct payments***	***Agri-env'ment***	***Other***	***Total***
Specialist sheep (LFA)					1,115 ha
Total output (£/ha)	36	30	11	6	83
Total costs (£/ha)	63	0	0	3	66
Farm bus. income (£/ha)	-27	30	11	2	16
Total output (£/farm)	40,395	33,246	12,427	6,167	92,235
Total costs (£/farm)	70,441	14	74	3,475	74,004
Farm bus. income (£/farm)	-30,046	33,231	12,354	2,692	18,231
Specialist cattle (LFA)					156 ha
Total output (£/ha)	711	241	49	60	1,060
Total costs (£/ha)	874	1	0	27	902
Farm bus. income (£/ha)	-163	240	49	33	159
Total output (£/farm)	110,877	37,583	7,672	9,303	165,435
Total costs (£/farm)	136,312	157	55	4,176	140,700
Farm bus. income (£/farm)	-25,435	37,426	7,618	5,127	24,734
Cattle and sheep (LFA)					528 ha
Total output (£/ha)	200	85	27	22	334
Total costs (£/ha)	258	0	0	14	272
Farm bus. income (£/ha)	-58	85	27	9	62
Total output (£/farm)	105,660	44,670	14,254	11,819	176,403
Total costs (£/farm)	136,438	21	76	7,220	143,754
Farm bus. income (£/farm)	-30,778	44,649	14,178	4,600	32,649

Source: Farm Business Survey, Scotland.

4.5.3 Farm H description

Farm H is a hill sheep farm in Easter Ross. It has around 70 ha of lower-quality in-bye land, and almost 2,200 ha of rough grazing of hard heathery ground. The farm's main enterprise is a breeding flock of approximately 600 ewes, a mixture of Cheviot and Blackface. The farm is run as a partnership between a father and son. The farm is currently in an AEC scheme, have previously been in a RP scheme, and they are enthusiastic about the opportunities of environmental schemes. There is a significant area of forestry as well as diverse shelterbelts on the farm and a hydro scheme (not shown in Figures).

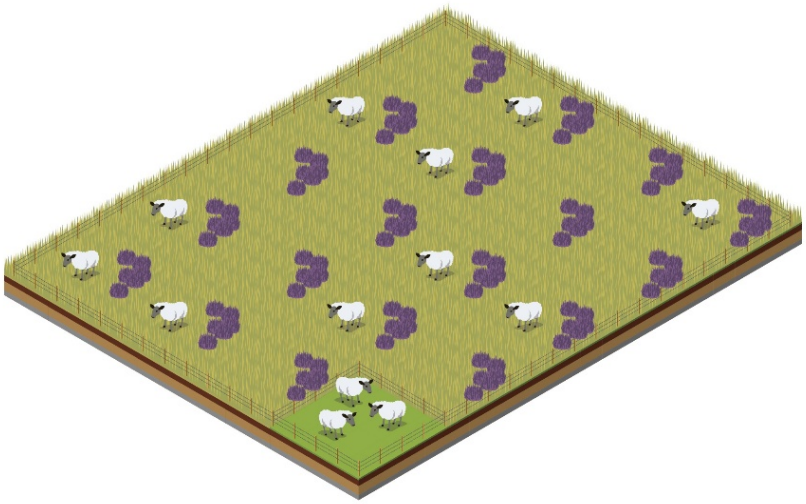

Figure 4.8: Schematic illustration of case study hill sheep farm H

Source: modified farm data. Key: see Annex 1

Easter Ross is a very diverse farming area, with predominantly suckler beef and sheep enterprises, but with many mixed farms towards the coast also including some arable. Farmers are mostly owner-occupiers, with a range of sizes from crofts to family farms and large estates. The case study farm is further up the hill than the areas used for arable, and typical of its more specific location.

4.6 Crofting

4.6.1 General description of farm type

Crofting is a farm type unique to Scotland[35]. A croft is a relatively small agricultural land holding which is most commonly held in tenancy and which may or may not have buildings or a house associated with it. While the average croft size is around 5 ha, crofts range in size from less than half hectare to more than 50 ha. There are approximately 20,570 crofts in Scotland, mainly in the crofting counties of the Highlands and Islands, and around 33,000 people live in crofting households. Most crofters engage with livestock production, while a large minority are also involved with crop production.

The Farm Structure Survey type General Cropping; Forage, with 21,100 holdings on nearly 1.3 million ha (on average 60 ha/holding) accounts for 20% of Scottish UAA and includes many crofts. Grassland accounts for 83% of the agricultural land area for this type (rotational grass 2%, permanent grass 17% and rough grazing 67%).

4.6.2 Financial results for farm type

The FBS does not report annually on this farm type. The crofting economic survey[12] reported that median incomes from crofting activities were £2,000, balanced by similar costs, while total household income including non-crofting activities was £25,000. The survey provided no specific information on the importance of basic payments or agri-environment payments, but does indicate that other diversification activities are often significant.

As no reliable data to create a representative farm type were available, two contrasting case study farms were analysed.

4.6.3 Croft C1 description

Croft C1 is a large, family-run croft in the Uists of around 150 ha of grassland, 20 ha of arable, and nearly 300 ha of rough grazing (in this case not common grazings). The arable ground is used to produce Uist corn (a mixture of oats and rye; typically half is cropped, and the other half is fallow). The vast majority is cut as whole-crop silage; a small amount may be combined for seed. They have around 40 suckler beef cattle and 170 breeding ewes. They claim basic payments and LFASS, are part of agri-environment schemes and interested to explore opportunities with agri-environment schemes further. The croft provides work for approximately one full-time equivalent worker.

Crofting is the main system of agriculture in the area, although the enterprises are more varied in type than Skye (Croft 2). Beef and sheep are produced, but a range of local varieties of barley, rye and oats are grown in the machair for silage and to save seed. Both common grazings and the machair are hugely important in the Uists. The relatively fertile machair land on the west, and the rough grazing on the east are typically common grazings. Seaweed has traditionally been commonly used from the shoreline for fertilisation.

[35] Black, C., Martin, C. & Warren, R. 2018. *Survey of the economic conditions of crofting 2015-2018.* Report by Ipsos MORI for Scottish Government, Edinburgh.

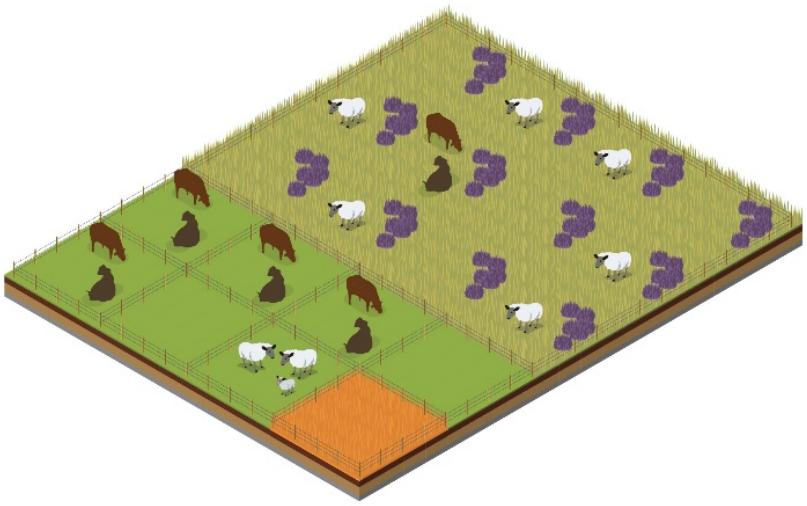

Figure 4.9: Schematic illustration of case study croft C1

Source: modified farm data. Key: see Annex 1

4.6.4 Croft C2 description

Croft C2 is a family run croft business in Skye that uses three crofts and their common grazings. A large area has been apportioned (around 140 ha) out of the total of over 400 ha of rough grazing. The croft has 220 breeding ewes and 10 breeding cows; calves and lambs are nearly all sold as stores. The apportionment includes an unspecified area of unfenced native woodland (not shown in Figure 4.10). The crofter considers the labour required as part-time although this varies significantly by season. They received some BPS, LFASS and SUSS payments in recent years, though this business has never participated in agri-environmental schemes as it was not felt that they were appropriate for the small area of in-bye land.

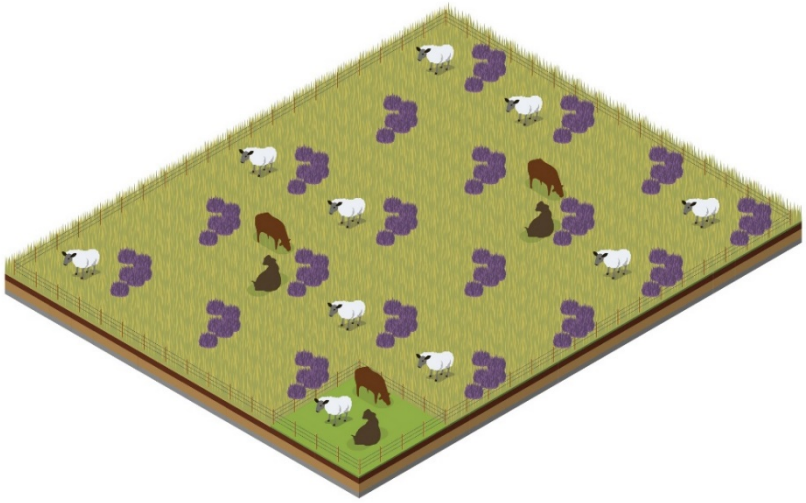

Figure 4.10: Schematic illustration of case study croft C2

Source: modified farm data. Key: see Annex 1.

Crofting is the main agricultural activity in Skye, with around 2,000 crofts on the island, though just a small fraction of those (around 5%) are large enough to support a full-time worker, with the vast majority providing part-time incomes. The main enterprises are suckler cows and sheep on grassland-based systems, with a variety of herd and stock sizes, and most crofts have associated common grazings which are used to different degrees.

5. SUSTAINABILITY ASSESSMENT

5.1 Introduction

Sustainability assessment tools provide a means of identifying the strengths and weaknesses of individual farms with respect to environmental, economic and social sustainability. They can be used in a variety of contexts, for example as:

- an advisory tool to help improve farm system performance;
- a policy tool to identify actions that might be supported and to monitor outcomes[36];
- or a business to business communication tool that can assist processors and retailers to monitor and communicate the sustainability of their food products and the agricultural ingredients used to produce them.

In recent years, a range of tools have been developed in an agricultural context, including RISE, SMART, Public Goods Tool (PGT), the Soil and More Sustainability Flower and the Cool Farm Tool. The European Commission is also developing FaST – a farm sustainability tool it hopes will be widely adopted by member states[37]. These tools are typically multi-objective in their approach (for example covering biodiversity, animal welfare, water, soil and air quality, farm business resilience and social issues), in contrast to many of the single-objective carbon footprinting tools also currently receiving attention. The pros and cons of the different approaches (with further information on their characteristics) have been considered in a report published by the Sustainable Food Trust[38].

In this study into alternative payments, a sustainability assessment was undertaken on each of the six case study farms using the Organic Research Centre's Public Goods Tool (PGT), developed in 2010 [39]. The PGT was developed primarily as an advisory tool and has been tested on both organic and non-organic farms in several different projects. The PG Tool focuses on 11 sustainability themes: Farm Business Resilience; Animal Health and Welfare; Landscape and Heritage; Water Management; Agri-environmental Management; Soil Management; Fertiliser Management and Farm Waste; Energy and Carbon; Agricultural Systems Diversity; Social Capital; and Food System/Security. Each theme is scored from 0 to 5, with 5 representing best performance.

The aim of using the PGT in this study was to highlight the farms' baseline provision of key public goods and any potential for improvement, and to relate this to one or more of the specific options being evaluated. The tool aimed to provide context on the case study farmers' current engagement with sustainable farming practices and it acted as a platform for discussion as to if, and in what areas, the proposed payment options might stimulate or inhibit increased provision of public goods.

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[36] Schader, C., Grovermann, C., Frick, R., Grenz, J. & Stolze, M. 2017. *Towards a new public goods payment model for remunerating farmers under the CAP Post-2020. Potential of Sustainability Assessment tools for Improving the Effectiveness, Efficiency, and Acceptance of the CAP.* FiBL and IFOAM EU Group, Frick.

[37] https://ec.europa.eu/info/news/new-tool-increase-sustainable-use-nutrients-across-eu-2019-feb-19_en. Currently the nutrient module is at an advanced stage of development, further modules covering different issues are planned.

[38] SFT. 2017. *Sustainability assessment: the case for convergence.* Sustainable Food Trust, Bristol. http://sustainablefoodtrust.org/wp-content/uploads/2013/04/Sustainability-Assessment.pdf

[39] Gerrard, C.L., Smith, L.G., Padel, S., Pearce, B., Hitchings, R., Measures, M. & Cooper, N. 2011. *OCIS Public Goods Tool Development*. Report for Defra, Organic Research Centre, Newbury.
Anon. 2014. *Application of the public goods tool on conventional farms.* Final report to Defra OF0398.
For links to these and further information on ORC's PG Tool, see:
http://www.organicresearchcentre.com/?go=Research%20and%20development&page=Resource%20use%20and%20sustainability&i=projects.php&p_id=20

5.2 Arable Farm A

5.2.1 Strengths

Farm A's scores ranged from 2.1 for Social Capital to 3.6 for Farm Business Resilience (Figure 5.1). Areas where the farm scored best (on the border of medium to good) were Soil Management, Fertiliser Management, Food System/Security, and Farm Business Resilience. Scores for Animal Health and Welfare are excluded as there were no animals on the farm.

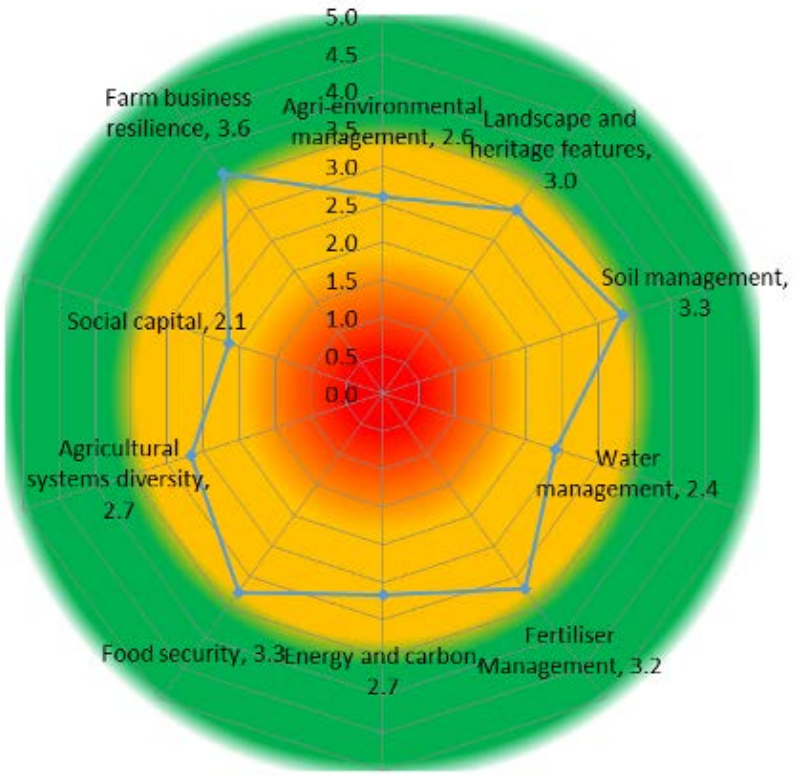


Figure 5.1: PGT sustainability scores for Farm A

Source: own assessment

5.2.2 Weaknesses and possible actions to address them

The farm scored low on Water Management due to the use of mains water and the disposal of untreated water into drains. To improve this score, rainwater harvesting and water recycling could be implemented.

Social Capital also scored low because of a low level of public access and community engagement. In discussion, the farmer was less keen on the idea of public access on the farm, but more so about possible community engagement activities and opportunities to improve staff skills and the Corporate Social Responsibility (CSR) credentials if financial rewards are available. They are willing to undertake more public benefit activities but feel they have to make financial and business sense and be practical alongside the main operations of the farm.

The Energy and Carbon score could also be improved with the use of renewables, energy monitoring and carbon calculation; all options with scope for assistance from public schemes or funding.

There is an opportunity to improve in the area of Agri-environmental Management (e.g. biodiversity surveys and conservation plans). While they are interested in exploring options

within AECS, it was previously felt that they would not score enough points to be eligible, based on what they were able to do on the farm. If the scoring systems or financial incentives for these were to change, these options may become more attractive.

5.2.3 Public good options that may be relevant

The farm already has hedges on most fields, but the uncropped margins and input reduction options could well be relevant. Given the dominance of barley in the cropping system, increased crop diversity (for example with extended rotations as in Conservation Agriculture) might well be applicable. All options and their financial impacts are reviewed in Chapter 6.

5.3 Dairy Farm D

5.3.1 Strengths

Farm D's sustainability scores varied quite widely, from 1.5 for Agricultural Systems Diversity to 4.0 for Animal Health and Welfare (Figure 5.2). Other areas where they scored well were Soil Management, Energy and Carbon, Social Capital and Farm Business Resilience.

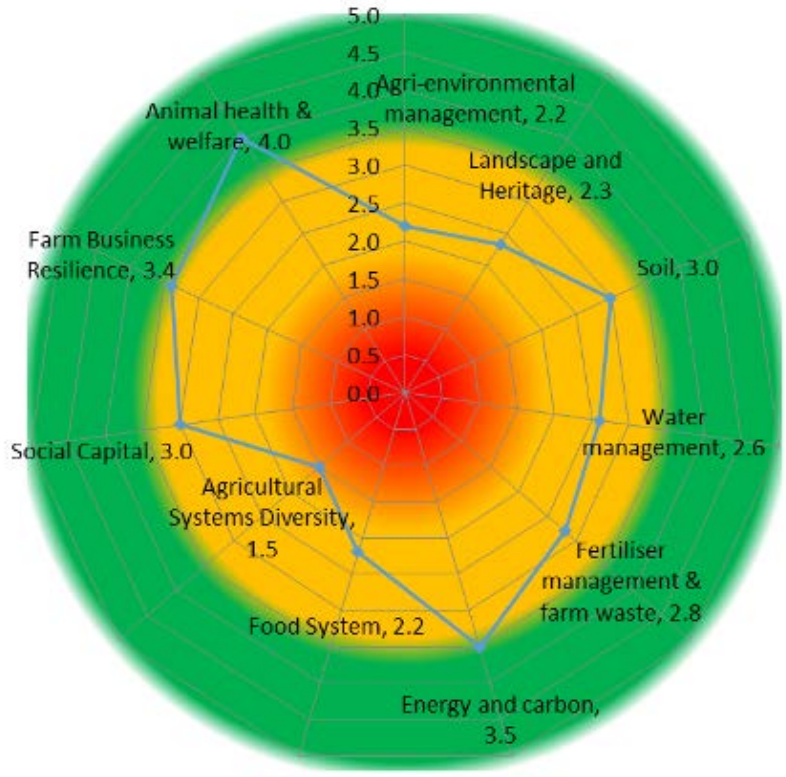


Figure 5.2: PGT sustainability scores for Farm D

Source: own assessment

The farmer was pleased to score well for Energy and Carbon, given that they have previously been a Climate Change Focus Farm as part of SAC's Farming For a Better Climate project, enabling them to monitor and manage their energy use, explore options for renewables and improve their efficiencies on the farm.

They felt that Animal Health and Welfare was relatively easy to score well on, compared to other categories. This may be related to the procedures and assurance schemes specific to milk production.

5.3.2 Weaknesses and possible actions to address them

There is an opportunity to improve in the area of Agri-environmental Management (e.g. biodiversity surveys and conservation plans), given the incentive to do so. Agricultural Systems Diversity was also low scoring, due to low cropland diversity (mostly permanent grass) and no on-farm processing or other diversification activities. The permanent grassland includes six species and deep rooting species for only a small part of the cropping cycle. This could potentially be improved and would increase the score for Soil Management also.

The farmer felt that the scoring for Landscape and Heritage was somewhat dependant on location and more a “luck of the draw” than something every farmer can work towards improving.

5.3.3 Public good options that may be relevant

Given the reluctance of the farmer to change current management practices, the uncropped field margins and input use reduction options (including the use of legumes in grassland) were the most relevant here. The hedge-based agroforestry was also an option that the farmer would consider. Uncropped field margins and hedges would contribute to improving the performance with respect to Agri-environmental Management, Agricultural Systems Diversity, and Landscape and Heritage scores.

5.4 Lowland livestock Farm L

5.4.1 Strengths

Farm L, the lowland livestock farm scored highest in Soil Management (4.0), Agricultural Systems Diversity (3.5) and Animal Health and Welfare (3.8), which they were pleased with (Figure 5.3). As traditional farmers, they believed in looking after their stock and farmland.

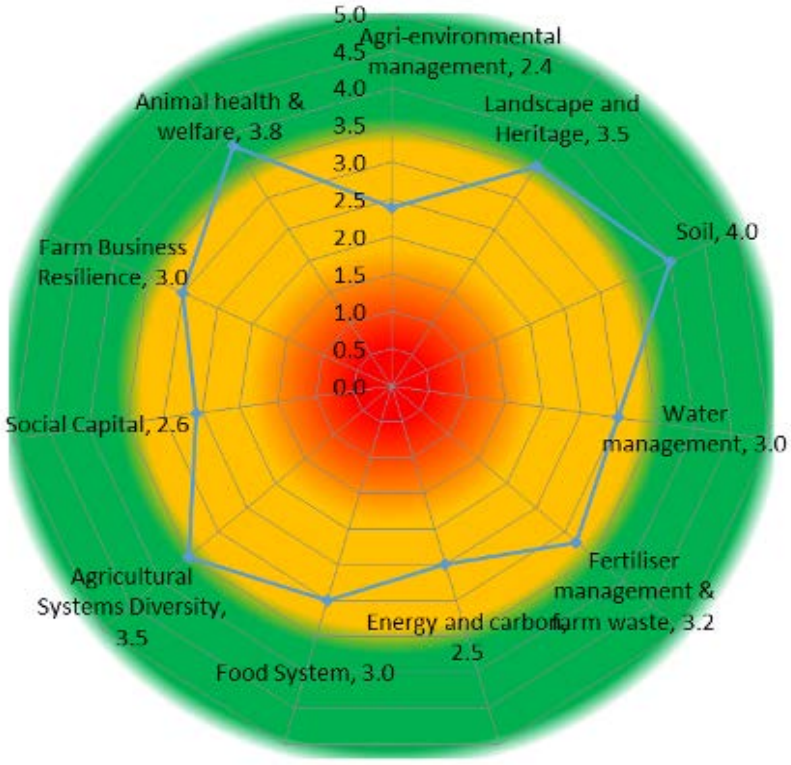


Figure 5.3: PGT sustainability scores for Farm L

Source: own assessment

5.4.2 Weaknesses and possible actions to address them

They scored lowest on Agri-environmental Management (2.4), which they were concerned about, as the scoring seemed to place an emphasis on rare species, and voluntary conservation plans, which they do not have. They believe they have a diverse range of habitats on the farm, with a mix of rotational and permanent grassland, along with cereal crops and forage brassicas, and feel they are doing as much as they can for wildlife in the area, without changing their system significantly. This production diversity, however, is captured more under the Agricultural Systems Diversity heading, where they scored highly.

The relatively low score (2.5) for Energy and Carbon highlighted that they have not embraced renewable technologies and are reliant on conventional sources of energy. They do however monitor energy use through cost of fuel and electric bills, but not specific usage (kWh of electricity or litres of fuel).

The Social Capital score was also quite low (2.6). Although they have not hosted open farm events, the farmer's son has spoken at schools/youth events about farming in the past. They have a public right of way through the farm, which is occasionally used by neighbours and dog walkers in the area, but they have also been subject to thefts from the farm. As a result, they are not keen to promote its use, as the path goes through the farm steading area. The scoring also highlighted that health and safety on the farm could be improved.

It was noted that the PG tool was helpful in raising the farmer's awareness of issues on his own farm.

5.4.3 Public good options that may be relevant

Uncropped margins, input reduction (including legumes in grassland) and agroforestry options could be relevant to improving the Agri-environmental Management score. The scattered individual trees agroforestry option suggested may be less appropriate on rotational grassland, but would still be relevant on the improved permanent grassland. Hedge plantings (as in the dairy case) might also be relevant.

5.5 Hill sheep Farm H

5.5.1 Strengths

Farm H, the hill sheep farm, had highest scores in Animal Health and Welfare (4.0), Fertiliser Management and Farm Waste (3.5) and Food System/Security (3.4), and lowest in Agricultural Systems Diversity (1.0), Water Management (2.2) and Agri-environmental Management (2.4) (Figure 5.4).

5.5.2 Weaknesses and possible actions to address them

As a hill sheep farm dominated by rough grazing, Agricultural Systems Diversity was difficult to score highly, due to the emphasis in the PGT on sown species, which does not reflect the true value of semi and unimproved grass swards that can be found on some hill farms. The low quality in-bye land with relatively few herbage species also contributed to the low score. While there may be some scope to reseed part of the in-bye land with multi-species swards, the impact is likely to be small. Diverse multi-species and multi-layer shelterbelts, which are non-productive but have potential for timber and biomass production, are already in place on some parts of the farm. There would be little incentive for the farmer to increase the breed diversity of the flock or on-farm processing or other diversification activities to improve their Agricultural Systems Diversity result.

Other than a lack of deep-rooting species in the grazing, Soil Management scored quite well at 3.3. The main way Water Management could be improved is through water harvesting and storage, but water supply is seen as a low risk area in general for this farm.

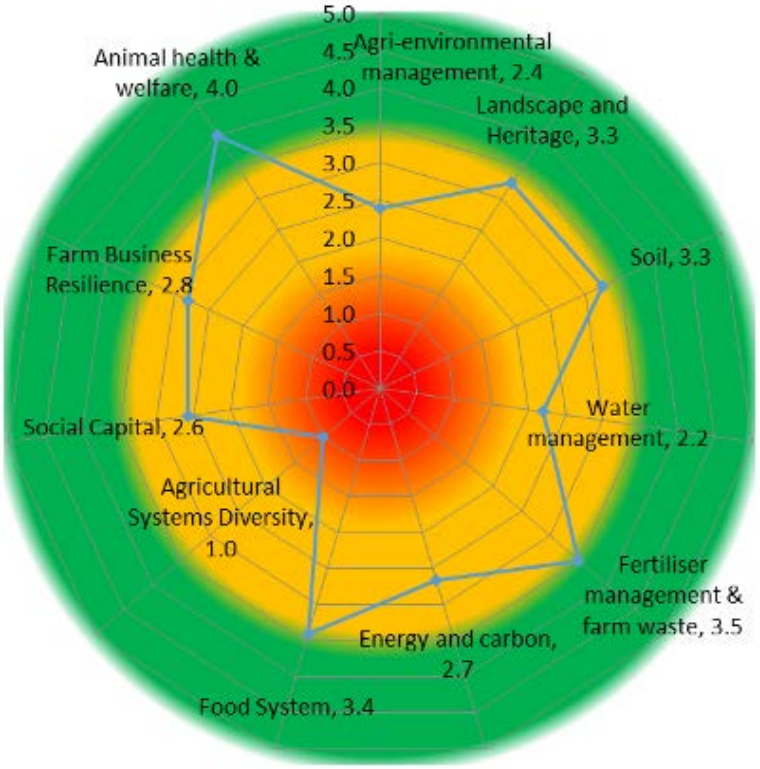


Figure 5.4: PGT sustainability scores for Farm H

Source: own assessment

As for the other case studies, the Energy and Carbon score could also be improved with use of renewables, energy monitoring and carbon calculation, all options with scope for assistance from public funding schemes. There is a hydropower scheme on the farm, with all energy exported to the grid, none is used on farm.

Benchmarking and creating a business plan would also help with Farm Business Resilience, and potentially interact with the lower scoring community engagement areas of Social Capital.

In discussion, the farmers' main concerns in relation to the impact of potential future options was the impact of organic measures on flexibility with regards to use of medicines and animal welfare. Given that they are very low input already, going organic could increase feed costs notably. They hoped future options would include a recognition of the environmental benefits of managing the moorland with sheep.

5.5.3 Public good options that may be relevant

Given the already low intensity of the farm, the input reduction options were less relevant to addressing issues emerging from the sustainability assessment. The hill sheep agroforestry option involving shelterbelts would be relevant to further develop the existing work on the farm. The farmer emphasised the importance of the current moorland management scheme – a variant of this could be relevant under the habitat conservation option.

5.6 Croft C1

5.6.1 Strengths

Croft C1, the Uist crofting case study, scored best in Animal Health and Welfare (4.3), Food System/Security (3.8), Agri-environmental Management (3.4) (Figure 5.5). This Croft is fairly representative of the characteristics of crofting in the western isles (e.g. high level of attention given to livestock, local markets for produce, high level of biodiversity).

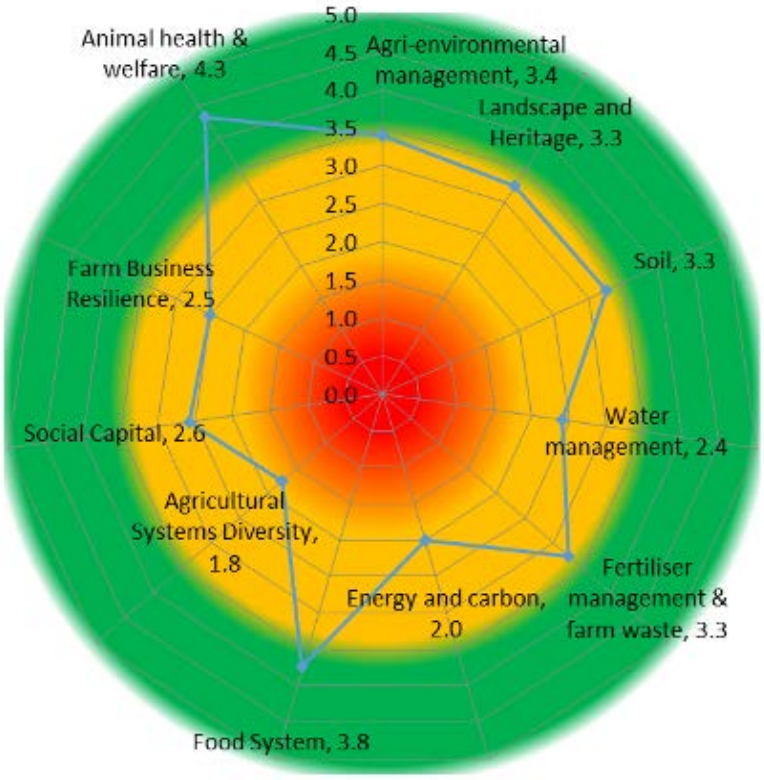


Figure 5.5: PGT sustainability scores for Croft C1

Source: own assessment

5.6.2 Weaknesses and possible actions to address them

It scored lowest in Agricultural Systems Diversity (1.8) and Energy and Carbon (2.0), which could be improved by increasing capacity to monitor energy and source renewables.

In general, many of the observations were similar to that of Croft C2, in that the PG tool was felt to give a reasonable impression of the business, but some unique features of crofting, and in this case specifically the machair systems, were not captured, or were downgraded in their importance or contributions. For example, the Agricultural Systems Diversity section looks for a higher amount of sown species in swards, which is relevant for improved grassland, but less relevant for the semi-improved, unimproved and species-rich grassland found on many crofts. The focus on these, from a nature conservation perspective, is to retain existing species-rich grasslands, without the risk of introducing inappropriate and potentially competitive varieties of plants. Hence the AECS options do not permit over-sowing on rough grazing land.

This is a High Nature Value croft. The moderate Farm Business Resilience score of 2.5 reflects the subsidy dependant nature of the croft.

5.6.3 Public good options that may be relevant

This croft already scores highly for Agri-environment Management – the habitat conservation option would support this activity. There is an abundance of wild plants that are not controlled, as they might be on a normal commercial farm. Agroforestry, both as wood pasture on some of the improved grassland and as diverse shelterbelts in the rough grazing areas would contribute to Agricultural Systems Diversity.

5.7 Croft C2

5.7.1 Strengths

The Skye crofting case study, Croft C2, did best in Animal Health and Welfare (4.3), Food System/Security (3.6) and Fertiliser Management and Farm Waste (3.3) (Figure 5.6). The high Animal Health and Welfare rating is not surprising given the importance of stockmanship on this croft and the relatively high labour to livestock ratio.

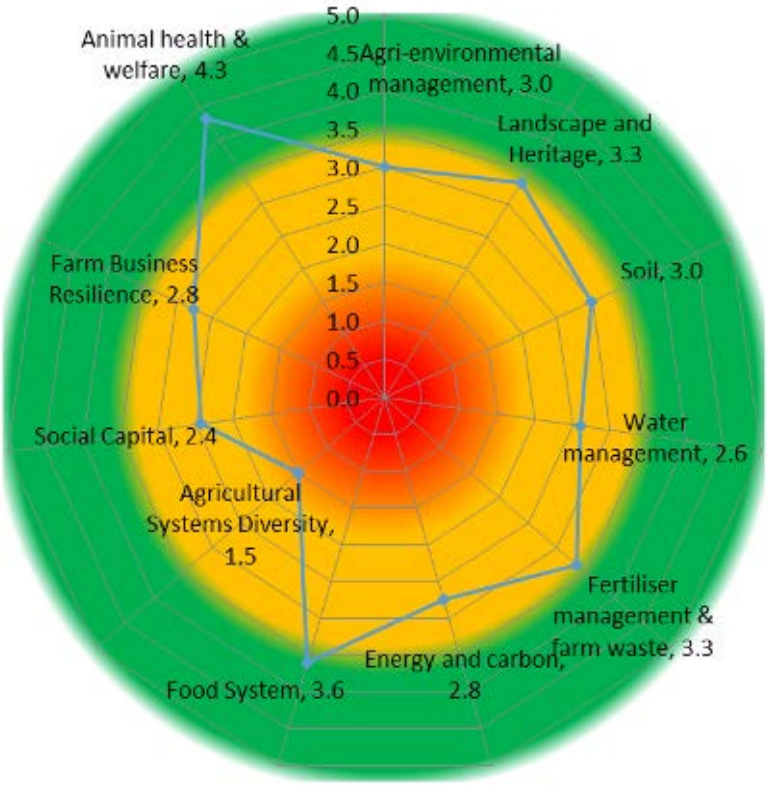


Figure 5.6: PGT sustainability scores for Croft C2

Source: own assessment

5.7.2 Weaknesses and possible actions to address them

This is a High Nature Value croft, which seems to conflict with the low score it attained for Agricultural Systems Diversity (1.5), due to the dominance of permanent grassland and rough grazing, and the medium score for Agri-environmental Management (3.0). The crofters feel that they are producing many public goods in conjunction with their common grazing (e.g. soil structure, public access, habitat for hen harriers, golden and sea eagles, native woodlands and semi-natural grasslands with rare species, and sensitive management of peat and limestone pavement areas).

The low agricultural systems diversity score is a result of many Skye crofts moving to being 100% pasture with no traditional small areas of arable crops remaining. This is a result of agricultural modernisation and a lack of support for retaining crop production. It would benefit crofting landscapes if small areas of arable could be re-established, but it would need support on a full cost basis and require support for machinery also. Similar to the hill farm case, the dependence on common rough grazing for livestock rearing, and limited ability to increase species diversity, negatively impacts on the score. There seem to be limited options for the croft to improve this within the scoring system, although both the hill sheep and crofting agroforestry options would be relevant in this context. There might also be some scope for enhancing species diversity within the permanent grassland.

Likewise, the low Social Capital score (2.4) does not reflect the crofting community and communal working of the common grazing. The PGT scoring system does not capture this, with its focus on more conventional measurements (e.g. farm shop, website and social media). The moderate Farm Business Resilience score of 2.8 reflects the subsidy-dependant nature of the croft.

As with Croft C1, the PG Tool seems to give a reasonable impression of the business, but some unique features of the crofting/machair system were either not captured or downgraded. For example, the diversity section looks for a higher amount of sown species, which is relevant for improved grassland, but less relevant on the semi-improved, unimproved and species-rich grassland found on many crofts.

5.7.3 Public good options that may be relevant

Croft C2 has many similarities with the hill sheep case study (Farm H). Given the already low intensity of the farm, the input reduction options were less relevant, but the hill sheep agroforestry option involving shelterbelts would be relevant to addressing the low Agricultural System Diversity score. A variant of the current AECS moorland management scheme for habitat conservation could also be appropriate.

5.8 Conclusions

The sustainability assessments on the case study farms illustrate the variability in possible outcomes on individual farms and demonstrate their potential to highlight both strengths and weaknesses.

For most of the farms apart from the crofts, Agri-environmental Management was a weakness. Options such as input reductions, uncropped field margins and the more ambitious habitat conservation and creation of nature-rich areas would improve outcomes for biodiversity. All farms and crofts except the lowland livestock farm scored low against Agricultural Systems Diversity and options such as crop diversification (e.g. conservation agriculture or organic farming) and agroforestry could be relevant.

If financial incentives for these options, and design of schemes, were to change under a public money for public goods approach, they could become more attractive as key components of the farm business.

Other weaknesses identified might not be so easily addressed by the options being evaluated in this study. Some, such as renewable energy or water harvesting might be more relevant to be addressed by Rural Development Programme productivity or capital investment schemes.

It was also highlighted that the PGT might need adaptation to better assess the hill/upland semi-natural rough grazing and machair contexts. These limitations of the tool have been considered when assessing the options that would contribute to farm sustainability.

6. FINANCIAL EVALUATION OF OPTIONS

6.1 Introduction

The financial evaluation of the options was conducted using SRUC's ScotFarm model (Section 6.1.1) to analyse both the case study farms (all types including the two crofting cases) and representative Farm Business Survey (FBS) farm types (general cropping for arable, dairy, lowland cattle and sheep, and LFA specialist sheep for hill sheep).

6.1.1 ScotFarm farm level modelling

SRUC's ScotFarm[40] is a farm level dynamic linear programming (LP) model that optimises farm profit subject to a number of limiting farm resources. The current version of the model was originally developed to conduct impact assessments of policy reforms such as CAP reform[41] and Brexit[42,43] on Scottish farms, with earlier versions having been used for studies of English dairy farms[44] and Irish livestock and crop farms[45,46]. The model is based on farming system analysis and includes biophysical and management relationships to link production to resource requirements which are used to the optimal levels. For example, availability of land, labour and feed required to generate a given volume of different outputs are combined with data on the prices of inputs and outputs to calculate farm net profit as an objective function to be maximised. The net profit is the total revenue generated from all farm activities plus subsidy payments received by the farm minus variable costs (i.e. input costs associated with farm activities) and fixed costs (machinery costs, depreciation, repairs, fuel, electricity, labour, rent, tax and others running costs). The production coefficients used in this tool are generated from the farm level data inputs.

For this study, the modelling time frame is set to 12 years allowing the farms to adjust farming activities under changed conditions. The model is adjusted to price effects during the 12-year time frame by using price projections generated by a partial equilibrium model, FAPRI_UK[47]. The model is run under a baseline scenario where no changes in policies are assumed during the modelling time frame, and under 10 different, alternative post-Brexit scenarios where changes in policy are assumed to be implemented fully from 2024. The model outputs (farm profits, farm production and farm structural changes) for the alternative scenarios post-2024 are compared with the baseline scenarios to assess the impact of alternative payments post Brexit for each of the farm types and case study farms, as shown in Figure 6.1.

[40] Further details available at: https://www.sruc.ac.uk/download/downloads/id/3513/scotfarm_%E2%80%93_a_farm_level_optimising_model.pdf

[41] Ahmadi, B. V., Shrestha, S., Thomson, S.G., Barnes, A.P. & Stott, A.W. 2015. Impacts of greening measures and flat rate regional payments of the Common Agricultural Policy on Scottish beef and sheep farms. *The Journal of Agricultural Science*, 153:676-688.

[42] Hubbard, C., Davis, J., Fend, S., Harvey, D., Liddon, A., Moxey, A., Ojo, M., Patton, M., Philippidis, G., Scott, C., Shrestha, S. & Wallace, M. 2018. Brexit: How will UK agriculture fare? *EuroChoices,* 17:19-26.

[43] Shrestha, S., Thomson, S., Ahmadi, B. V. & Barnes, A. 2018. Assessing the impacts of alternative post-Brexit trade and agricultural support policy scenarios on Scottish farming systems. LEES, SRUC. https://www.sruc.ac.uk/downloads/file/3606/assessing_the_impacts_of_alternative_post-brexit_trade_and_agricultural_support_policy_scenarios_on_scottish_farming_systems

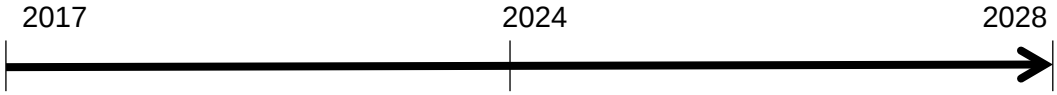
[44] Shrestha, S., Gibbons, J. & Ramsden, S. 2004. Dairy farms in central England under climate change in 2050s: do they need to change? Abstract of Communications, *Journal of Agricultural Science,* 142:246-247.

[45] Shrestha, S., Hennessy, T. & Hynes, S. 2007. The effect of decoupling on farming in Ireland: a regional analysis. *Irish Journal of Agriculture and Food Research*, 46:1-13.

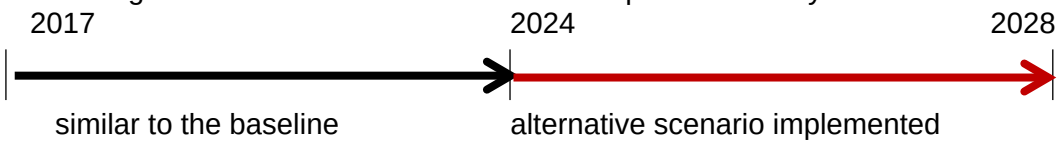
[46] Hennessy, T., Shrestha, S. & Farrell, M. 2008. Quantifying the viability of farming in Ireland: can decoupling address the regional imbalances? *Irish Geography*, 41:29-47.

[47] For details see https://www.afbini.gov.uk/publications/fapri-uk-model-documentation

Baseline scenario (existing policies and payment continue till 2028):



Alternative payment scenarios (continue with the conditions under the Baseline scenario till 2024 and changes under alternative scenarios are implemented fully from 2024 onwards)



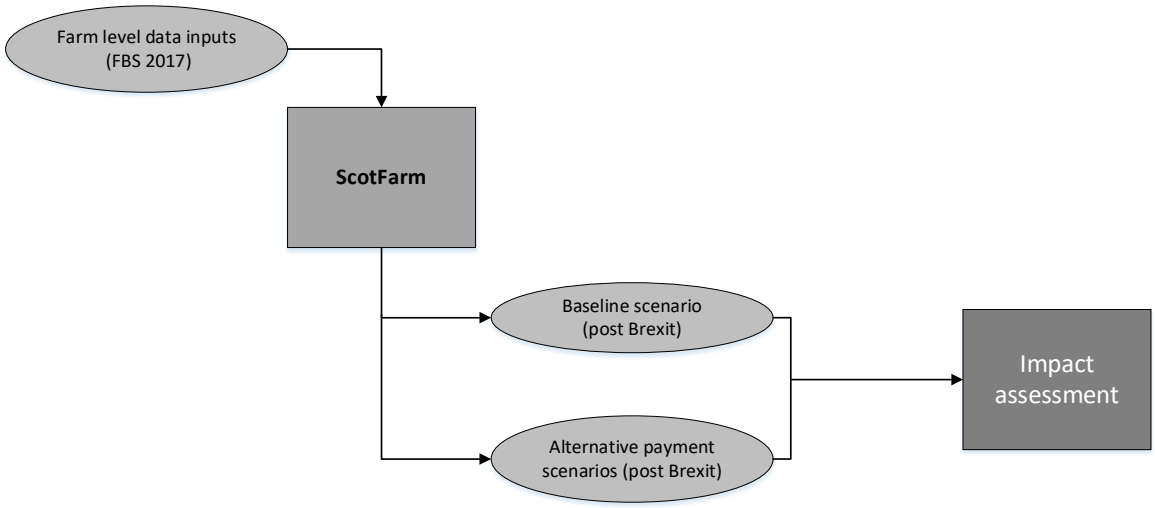


Figure 6.1: Schematic illustration of the modelling approach.

The model was first configured to each of the farm types (representative and case study farms) under a pre-Brexit payment support (baseline) scenario. The model was then run under the following alternative environment payment support scenarios:

1. Improved input use efficiency (10 and 20% reductions)
2. Uncropped field margins (environmental set-aside, 5 and 10% of land area)
3. 1 and 2 combined
4. Conservation agriculture (including grain legumes, zero tillage and catch crops)
5. Organic farming
6. Agroforestry, with different variations for each farm type: alley cropping with fruit trees for arable; hedge rows with in-hedge trees for dairying; scattered trees in pasture for lowland livestock; shelterbelts for hill sheep; wood pasture for crofting.

It should be noted that the baseline scenario modelled does not represent the current (2017/18) results for the farm types or case study farms, but is a projection for future outcomes based on current policies being maintained.

Further options were assessed based on pro rata adjustments to the baseline model results generated for the other options, as they were not amenable to direct evaluation with the modelling approach used:

7. Habitat conservation (20% of land on the farm)
8. Nature restoration (50% of land on the farm)

For 7. Habitat conservation, it was not possible to account directly for pre-existing habitats on farms and the focus was on new areas. However, the baseline agri-environment payments recorded reflect, in part at least, participation in options to protect pre-existing habitats. As mentioned in chapter 4, woodlands and other non-agricultural land uses have been excluded, on the basis that the woodlands were more likely to be commercial forestry and the model does not allow for distinction between commercial forestry and native woodlands. Further information on these options can be found in Chapter 3.

6.1.2 Data sources

Data inputs for the representative farm types (arable, dairy, lowland livestock and hill sheep) were taken from the Farm Business Survey (FBS 2017). For modelling the impacts on the case study farms, relevant actual farm data were obtained as part of the case study farm visits. In some cases, manual adjustments were made to the model results, so as:

- to include crops like potatoes that are not part of the ScotFarm model;
- to ensure relevant structural outcomes for organic farming; and
- to evaluate the habitat conservation and nature restoration options (by reducing baseline crop and livestock margins pro rata and, in the nature restoration case, reducing fixed costs by 25%).

Data for making these adjustments were obtained either from the model results, or from relevant data sources including the 2017 SRUC Farm Management Handbook[48] and the 2017 ORC Organic Farm Management Handbook[49]. The Soil Association's 2019 Agroforestry Handbook[50] was also used as a data source for the modelling of the agroforestry options.

6.1.3 Model limitations

Despite our efforts to ensure high quality results from the models, there are some limitations to the modelling that mean the results need to be interpreted with caution. The modelling is intended to help compare and illustrate different options, rather than provide in-depth financial assessments.

- Future prices are estimated exogenously by an external sectoral model, FAPRI and may not in practice become reality.
- Yields and input costs are based on current values and may change over time.
- Gross margins (yield x price less variable input costs) will vary in proportion to number of hectares or animals selected by the model, but the fixed costs (such as labour, machinery, land etc.) do not and are assumed to be constant. This may not be an issue where the options do not involve significant structural changes, but in situations like organic farming or nature restoration affecting the whole or large parts of the farm, fixed costs may well be affected. We have assumed constant fixed costs for all options except 50% nature restoration, where a 25% reduction in fixed costs has been assumed.
- Labour is one fixed cost which the model does attempt to calculate, but on the basis of integer (whole labour unit) values. In some cases, all labour is assumed to be provided by family labour, and paid labour will only be included if profitability is increased sufficiently to justify one or more full-time employees. Alternatively, for example in organic farming, if stock numbers fall sufficiently, labour use may be reduced. This is the case for the dairy farm type, where labour costs are shown separately. Some

[48] https://www.fas.scot/publication/farm-management-handbook-20172018/
[49] Lampkin, N., Measures, M. & Padel, S. (eds.) 2017. 2017 Organic Farm Management Handbook. 11th edition. Organic Research Centre, Newbury. 250pp
[50] Raskin, B. & Osborn, S. 2019. The Agroforestry Handbook. Soil Association, Bristol. https://www.soilassociation.org/farmers-growers/technicalinformation/agroforestry-handbook/

reductions in labour use have also been assumed for the 20% habitat conservation and 50% nature restoration options.

- Establishment costs are not separately identified and may be particularly significant for organic, agroforestry, habitat conservation and nature restoration options. Where appropriate, we have indicated potential establishment costs below.

For illustrative purposes, we have shown the basic and agri-environment payments as unchanged for all options, as this provides the context for future funding of the options.

6.2 Arable farms

For a description of the arable farm type and case study Farm A, see Section 4.2. The structural and financial characteristics of the baseline models are detailed in Table 6.1 for the FBS representative farm and Table 6.2 for the case study farm. These tables also provide the model results for all options. Commercial forestry and native woodlands already present on the farms are not included in the tables and figures presented.

The FBS representative arable farm baseline model is 194 ha, of which 77 ha are barley and 31ha are wheat. Oilseed rape, potatoes and vegetables have been added manually to the model results to reflect the general cropping farm type (see Figure 6.2). Small beef and sheep enterprises are kept on 51 ha of grassland. The representative farm generates a net profit before subsidies of nearly £54k (£277/ha). Support payments add £41k to that, resulting in a total net profit of £95k.

The case study arable Farm A baseline model is 164 ha, of which 126 ha are barley and 10 ha are wheat (see Figure 6.3). Potatoes have been added manually to the model results. There are 22 ha of grassland, but no livestock are kept. Any forage harvested is sold off the farm. Farm A generates a net profit before subsidies of nearly £2k (£11/ha). Support payments add £27k to that, resulting in a total net profit of £29k.

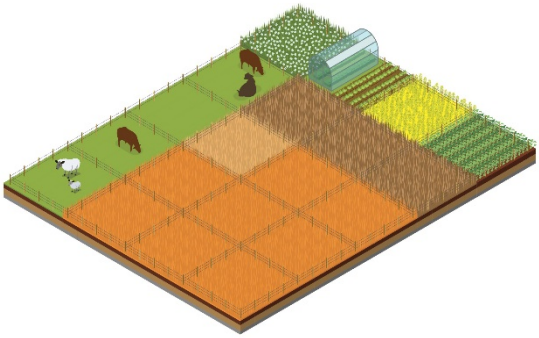


Figure 6.2: FBS representative cropping farm, 194 ha, baseline

Source: own estimates; Key: see Annex 1

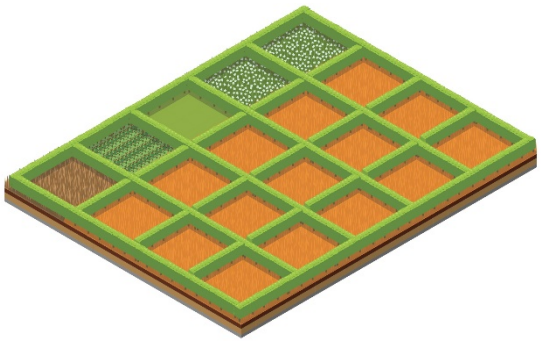


Figure 6.3: Case study cropping farm A, 164 ha, baseline

Source: own estimates; Key: see Annex 1

6.2.1 Reduced agrochemical inputs and increased input use efficiency

Two versions of this option have been analysed, involving 10% and 20% reductions in input use, with crop yields maintained as a result of improved efficiency. Cropped areas, livestock numbers and fixed costs are assumed to remain constant. For the FBS representative farm, gross margins increase by ca. £18/farm ha (£3.5k/farm) for each 10% reduction in input use, due to the improvement in production efficiency. For Farm A, gross margins were estimated to increase by £27/farm ha (£4.5k/farm) for each 10% reduction in input use. The potential win-win for farm profits and the environment with this option suggest public support should be focused on information and advisory support and planning tools, to encourage greater uptake.

Table 6.1: Model results for arable FBS representative farm

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	4: Conservation agriculture	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)													
Arable land	143.3	143.3	143.3	135.6	127.9	135.6	127.9	143.3	118.0	135.6	127.9	123.9	97.2
barley	77.1	77.1	77.1	73.0	69.0	73.0	69.0	80.4	62.0	73.0	69.0	73.4	60.2
wheat	30.7	30.7	30.7	29.0	27.0	29.0	27.0	18.9	31.0	29.0	27.0	21.0	21.0
oats	8.6	8.6	8.6	8.0	7.7	8.0	7.7	4.0	7.0	8.0	7.7	8.6	0.0
field beans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.0	0.0	0.0	0.0	0.0	0.0
oilseedrape	4.9	4.9	4.9	4.7	4.4	4.7	4.4	0.0	0.0	4.7	4.4	4.9	0.0
potatoes	10.0	10.0	10.0	9.5	9.0	9.5	9.0	10.0	8.0	9.5	9.0	10.0	10.0
fruit/veg	6.0	6.0	6.0	5.7	5.4	5.7	5.4	6.0	5.0	5.7	5.4	6.0	6.0
other (fallow/fodder)	6.0	6.0	6.0	5.7	5.4	5.7	5.4	0.0	5.0	5.7	5.4	0.0	0.0
Agroforestry trees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2	20.5	0.0	0.0
Grassland	51.0	51.0	51.0	48.5	45.9	48.5	45.9	51.0	76.3	48.5	45.9	31.6	0.0
permanent grass	39.3	39.3	39.3	37.8	35.2	37.8	35.2	39.3	39.3	38.2	36.0	19.9	0.0
rotational grass	9.0	9.0	9.0	8.0	8.0	8.0	8.0	9.0	34.3	7.6	7.2	9.0	0.0
rough grazing	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	0.0
Uncropped (Eco)	0.0	0.0	0.0	10.2	20.5	10.2	20.5	0.0	0.0	0.0	0.0	38.9	97.2
Total hectares	194.3	194.3	194.3	194.3	194.3	194.3	194.3	194.3	194.3	194.3	194.3	194.3	194.3
Livestock (head)													
beef	17	17	17	17	17	17	17	17	40	17	17	12	10
sheep	27	27	27	27	27	27	27	27	75	27	27	19	0
Livestock units (LU)	43	43	43	43	43	43	43	43	51	43	43	30	20
Stocking rate (LU/for.ha)	0.84	0.84	0.84	0.89	0.94	0.89	0.94	0.84	0.67	0.89	0.94	0.94	0.21
Financial data (£/farm)													
Gross margin	154579	157872	161615	147693	140807	150826	146749	161549	195646	184492	216289	142658	115211
crops	137704	140933	144612	130819	123933	133887	129746	144598	154344	167618	199415	130746	106570
beef	14691	14749	14807	14690	14690	14749	14807	14690	35160	14690	14690	10370	8642
sheep	2184	2190	2196	2184	2184	2190	2196	2261	6142	2184	2184	1542	0
Fixed costs	100797	100797	100797	100797	100797	100797	100797	100797	100797	100797	100797	100797	75598
Net profit (excl. subsidies)	53782	57075	60818	46896	40010	50029	45952	60752	94849	83695	115492	41861	39614
Basic payment	41062	41062	41062	41062	41062	41062	41062	41062	41062	41062	41062	41062	41062
Agri-env payment	339	339	339	339	339	339	339	339	339	339	339	339	339
Net profit (incl. subsidies)	95183	98476	102219	88297	81411	91430	87353	102153	136250	125096	156893	83262	81015
Financial data (£/farm ha)													
Gross margin	796	813	832	760	725	776	755	831	1007	950	1113	734	593
crops	709	725	744	673	638	689	668	744	794	863	1026	673	548
beef	76	76	76	76	76	76	76	76	181	76	76	53	44
sheep	11	11	11	11	11	11	11	12	32	11	11	8	0
Fixed costs	519	519	519	519	519	519	519	519	519	519	519	519	389
Net profit (excl. subsidies)	277	294	313	241	206	257	237	313	488	431	594	215	204
Basic payment	211	211	211	211	211	211	211	211	211	211	211	211	211
Agri-env payment	2	2	2	2	2	2	2	2	2	2	2	2	2
Net profit (incl. subsidies)	490	507	526	454	419	471	450	526	701	644	807	429	417
Difference compared with baseline (£/farm)													
Gross margin	0	3293	7036	-6887	-13772	-3754	-7830	6970	41067	29913	61710	-11921	-39368
crops	0	3229	6908	-6886	-13771	-3818	-7958	6894	16640	29914	61711	-6958	-31134
beef	0	58	116	-1	-1	58	116	-1	20469	-1	-1	-4321	-6049
sheep	0	6	12	0	0	6	12	77	3958	0	0	-642	-2184
Fixed costs	0	0	0	0	0	0	0	0	0	0	0	0	-25199
Net profit (excl. subsidies)	0	3293	7036	-6887	-13772	-3754	-7830	6970	41067	29913	61710	-11921	-14168
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	3293	7036	-6887	-13772	-3754	-7830	6970	41067	29913	61710	-11921	-14168
Difference compared with baseline (£/farm ha)													
Gross margin	0.0	16.9	36.2	-35.4	-70.9	-19.3	-40.3	35.9	211.4	154.2	317.6	-61.4	-202.6
crops	0.0	16.6	35.6	-35.4	-70.9	-19.6	-41.0	35.5	85.6	154.2	317.6	-35.8	-160.3
beef	0.0	0.3	0.6	0.0	0.0	0.3	0.6	0.0	105.3	0.0	0.0	-22.2	-31.1
sheep	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.4	20.4	0.0	0.0	-3.3	-11.2
Fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-129.7
Net profit (excl. subsidies)	0.0	16.9	36.2	-35.4	-70.9	-19.3	-40.3	35.9	211.4	154.1	317.6	-61.4	-72.9
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	16.9	36.2	-35.4	-70.9	-19.3	-40.3	35.9	211.4	154.1	317.6	-61.4	-72.9

Table 6.2: Model results for arable case study Farm A

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	4: Conservation agriculture	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)													
Arable land	141.9	141.9	141.9	135.5	128.9	135.4	129.0	153.5	115.6	135.4	128.9	124.4	81.8
barley	126.4	126.4	126.4	120.1	113.8	120.1	113.8	118.0	101.1	120.0	114.0	110.0	67.4
wheat	10.5	10.5	10.5	9.9	9.4	9.9	9.4	6.5	10.5	9.9	9.4	9.4	9.4
oats	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
field beans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.8	0.0	0.0	0.0	0.0	0
potatoes	5.0	5.0	5.0	4.8	4.5	4.8	4.5	5.0	4.0	4.8	4.5	5.0	5
Agroforestry trees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	14.2	0.0	0
Grassland	21.7	21.7	21.7	21.0	20.5	21.1	20.4	10.1	48.0	21.1	20.5	6.4	0.0
permanent grass	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	24.0	9.5	9.5	2.4	0
rotational grass	12.2	12.2	12.2	11.5	11.0	11.6	10.9	0.6	24.0	11.6	11.0	4.0	0
Uncropped (Eco)	0.0	0.0	0.0	7.1	14.2	7.1	14.2	0.0	0.0	0.0	0.0	32.7	81.8
Total area	163.6	163.6	163.6	163.6	163.6	163.6	163.6	163.6	163.6	163.6	163.6	163.6	163.6
Livestock (LU)	0	0	0	0	0	0	0	0	32	0	0	0	0
Stocking rate (LU/for. ha)	0	0	0	0	0	0	0	0	0.67	0	0	0	0
Financial data (£/farm)													
Crop gross margin	96931	101317	105702	86460	80488	89126	88382	106555	95926	109793	130153	85181	57764
Livestock gross margin	0	0	0	0	0	0	0	0	19627	0	0	0	0
Fixed costs	95212	95212	95212	95212	95212	95212	95212	95212	95212	95212	95212	95212	71409
Net profit (excl. subsidies)	*1719*	*6105*	*10490*	*-8752*	*-14724*	*-6086*	*-6830*	*11343*	*20341*	*14581*	*34941*	*-10031*	*-13645*
Basic payment	26043	26043	26043	26043	26043	26043	26043	26043	26043	26043	26043	26043	26043
Agri-env payment	747	747	747	747	747	747	747	747	747	747	747	747	747
Net profit (incl. subsidies)	*28509*	*32895*	*37280*	*18038*	*12066*	*20704*	*19960*	*38133*	*47131*	*41371*	*61731*	*16759*	*13145*
Financial data (£/farm ha)													
Crop gross margin	592	619	646	528	492	545	540	651	586	671	796	521	353
Livestock gross margin	0	0	0	0	0	0	0	0	120	0	0	0	0
Fixed costs	582	582	582	582	582	582	582	582	582	582	582	582	436
Net profit (excl. subsidies)	11	37	64	-53	-90	-37	-42	69	124	89	214	-61	-83
Basic payment	159	159	159	159	159	159	159	159	159	159	159	159	159
Agri-env payment	5	5	5	5	5	5	5	5	5	5	5	5	5
Net profit (incl. subsidies)	174	201	228	110	74	127	122	233	288	253	377	102	80
Difference compared with baseline (£/farm)													
Crop gross margin	0	4386	8771	-10471	-16443	-7805	-8549	9624	-1005	12862	33222	-11750	-39167
Livestock gross margin	0	0	0	0	0	0	0	0	19627	0	0	0	0
Fixed costs	0	0	0	0	0	0	0	0	0	0	0	0	-23803
Net profit (excl. subsidies)	0	4386	8771	-10471	-16443	-7805	-8549	9624	18622	12862	33222	-11750	-15364
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	4386	8771	-10471	-16443	-7805	-8549	9624	18622	12862	33222	-11750	-15364
Difference compared with baseline (£/farm ha)													
Crop gross margin	0.0	26.8	53.6	-64.0	-100.5	-47.7	-52.3	58.8	-6.1	78.6	203.1	-71.8	-239.4
Livestock gross margin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	120.0	0.0	0.0	0.0	0.0
Fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	-145.5
Net profit (excl. subsidies)	0.0	26.8	53.6	-64.0	-100.5	-47.7	-52.3	58.8	113.8	78.6	203.1	-71.8	-93.9
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	26.8	53.6	-64.0	-100.5	-47.7	-52.3	58.8	113.8	78.6	203.1	-71.8	-93.9

6.2.2 Environmental set-aside

Two versions of this option have been analysed, involving 5% and 10% of land area designated primarily for wildlife and ecosystem service provision. These are similar to the current policies for 5% ecological focus areas as part of Greening and, in the 10% case, at least 6m unharvested conservation headlands (AECS). In some cases, less productive land may be set-aside, or production levels (livestock numbers) on the remaining land intensified, so that total output may be maintained, but in the arable case, crop areas are reduced.

For the FBS representative farm (Figure 6.4), net profit (before support payments) is reduced by £35/farm ha[51] (£6.9k/farm) for each 5% set-aside. This is equivalent to £700/ha for the land actually set-aside. Farm A results (Figure 6.5) indicate £64/farm ha (£10k/farm) reduction for the first 5%, but only £100/farm ha for 10% reduction, equivalent to £1000/ha for the land actually set aside.

Under the current AECS, the £658/ha uncropped margin option payment is limited to 5 ha on land holdings up to 250 ha, while the 5% EFA requirement is covered by the Basic Payment. If implemented on a whole farm basis, this option would utilise 17 or 33% (for 5% or 10% variants respectively) of the baseline basic payments for the FBS representative farm, and 40 or 63% for Farm A.

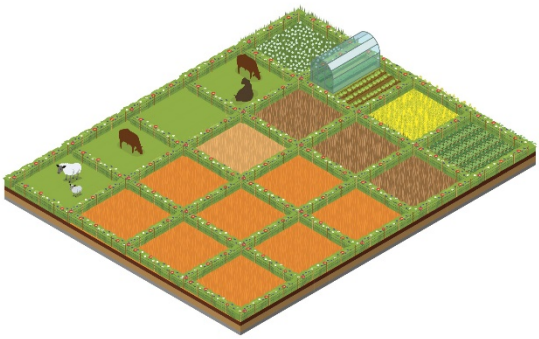


Figure 6.4: FBS representative cropping farm, 194 ha, uncropped field margins

Source: own estimates; Key: see Annex 1

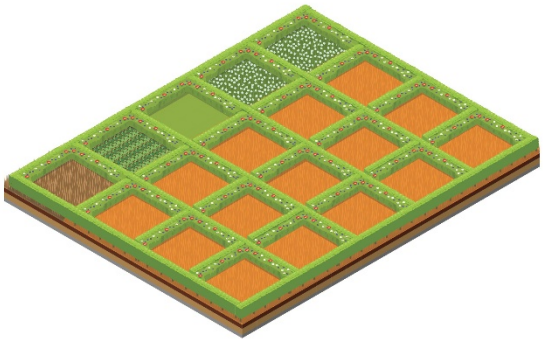


Figure 6.5: Case study cropping farm A, 164 ha, uncropped field margins

Source: own estimates; Key: see Annex 1

6.2.3 Options 1 and 2 combined

The above two options could be combined on the same field, with one focused on the field margins and the other focused on the cropped land. For the FBS representative arable farm, this would result in a net profit reduction of about £20/farm ha (£4k/farm) with 5% set-aside and 10% input reduction or £40/farm ha (£8k/farm) with 10% set-aside and 20% input reduction. For Farm A, both variants resulted in a net profit reduction of about £50/farm ha (£8k/farm).

If implemented on a whole farm basis, these combinations would utilise 9-19% of the baseline basic payments for the FBS representative farm, or around 30% for Farm A.

6.2.4 Conservation agriculture

For arable farms, conservation agriculture featuring extended rotations including grain legumes and catch crops, as well as the use of zero tillage, could offer significant diversity and soil health benefits. No adjustments have been made for the impact of grain legumes on yields of the following crop. For the FBS representative farm, the requirement for field beans one year in six of the rotation had the effect of eliminating oilseed rape and some cereals (Figure 6.6). In the Farm A case, legumes replaced rotational grass and some of the cereals (Figure 6.7), reducing the intended crop diversification effect. However, the combination of changes resulted in improved profitability for both farms, with net profit increasing on the FBS representative farm by £36/farm ha (£7k/farm) and on Farm A by £59/farm ha (£10k/farm).

[51] The term 'per farm ha' is used where values are averaged over all the land on the farm. This is to be distinguished from the values per actual ha taken out of production or utilising part of a field, as in the agroforestry case.

As with Option 1 (reduced input use) the combined financial and environmental gains might suggest an information and advisory support initiative could be effective. However, there are legitimate concerns about the reliability of grain legumes in some Scottish arable farming contexts, and whether increased output of grain legumes might not find markets. This will depend in part on whether imported grain legumes for livestock feed can be substituted and new markets for human consumption explored.

There may be scope for this option to be combined with other options (e.g. environmental set-aside, agroforestry, habitat conservation and nature regeneration) but these possible combinations have not been analysed separately.

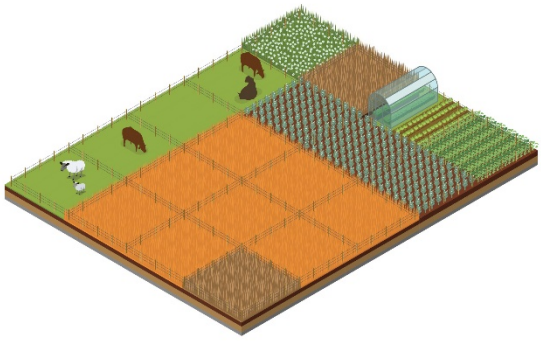


Figure 6.6: FBS representative cropping farm, 194 ha, conservation agriculture

Source: own estimates; Key: see Annex 1

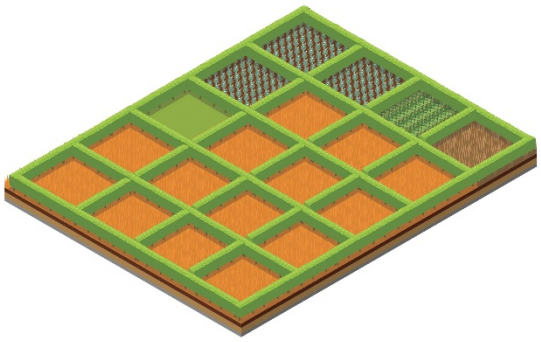


Figure 6.7: Case study cropping farm A, 164 ha, conservation agriculture

Source: own estimates; Key: see Annex 1

6.2.5 Organic farming

Organic farming on arable farms requires the inclusion of fertility-building clover-grass leys (rotational grassland) in the crop rotations. This can vary from 20-50% of the tillage area; in these calculations we have assumed at least 25%. The increased grassland area on the FBS representative farm permits more livestock to be kept, even though stocking rates per forage ha are estimated to be 20% lower than under non-organic management. The barley area is reduced, and oilseed rape dropped, while potato and vegetable areas are maintained (Figure 6.8). On Farm A, leys are introduced at the expense of barley and some existing rotational grassland assumed to become permanent (Figure 6.9). For farms without livestock, stockless organic arable production may be an option, the key issue being how to make profitable use of the fertility-building leys. We have assumed in this case that a sheep enterprise is introduced.

Although crop yields are reduced under organic management, premium prices for organic food and lower input costs compensate, often generating higher gross margins per ha. On the FBS representative farm, net profit before subsidies is estimated to increase by £211/farm ha (£41k/farm). For Farm A, net profit is estimated to increase by £114/farm ha (£19k/farm). These increases are not reflected on the other farm types, and there is a case that the price premiums achieved for organic crops, which may be worth over £500/ha, are a reflection of investments in organic marketing initiatives, not a result of delivering environmental benefits, and maybe should be discounted. There is also a need to consider the conversion (establishment) costs associated with restructuring farming enterprises (including livestock introduction) and the lack of access to premium prices during the conversion period.

The current AECS organic options provide for a higher rate conversion payment (first two years only) of: arable £280/ha, improved grass £140/ha and rough grazing £12.50/ha. For subsequent maintenance the rates are: arable £65/ha, improved grass £55/ha and rough grazing £8.50/ha.

As with conservation agriculture, there may be scope for this option to be combined with other options (e.g. agroforestry, habitat conservation and nature regeneration) but these possible combinations have not been analysed separately. The case for combination with environmental set-aside is less convincing, due to the reductions in input use and increased environmental benefits on a whole field basis.

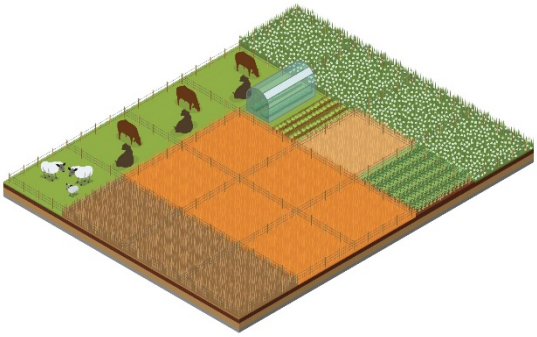


Figure 6.8: FBS representative cropping farm, 194 ha, organic farming

Source: own estimates; Key: see Annex 1

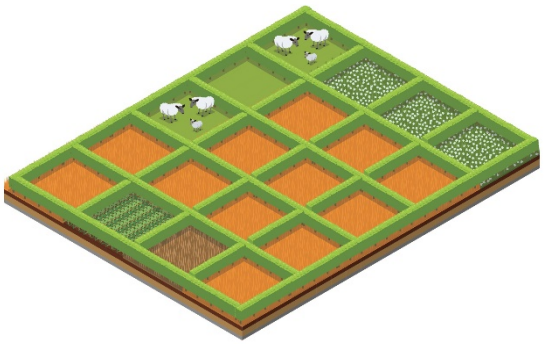


Figure 6.9: Case study cropping farm A, 164 ha, organic farming

Source: own estimates; Key: see Annex 1

6.2.6 Agroforestry

Two agroforestry options have been evaluated involving 5% or 10% of land being occupied by trees. In the arable case, this is primarily based on an alley-cropping system with trees as a cash crop. In this analysis fruit (apples) has been assumed, but nuts or biofuel crops such as willow or hazel might also be applicable. Assuming the tree rows occupy 3m widths at >24m spacings between them, then the agroforestry component will take up 10% of the area on a given field, and the 5% version of the option represents 50% of the total farmland being allocated to agroforestry. In the FBS representative farm case, some agroforestry on permanent grassland has been included (Figure 6.10). It would also be relevant to consider the introduction of hedges on farms where hedges are absent or limited, but this has not been analysed in the arable case. Farm A in any case is well supplied with hedges (Figure 6.11).

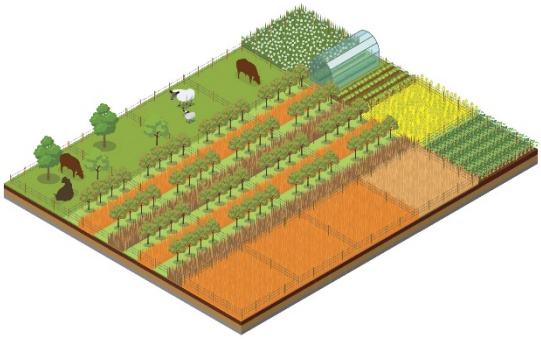


Figure 6.10: FBS representative cropping farm, 194 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

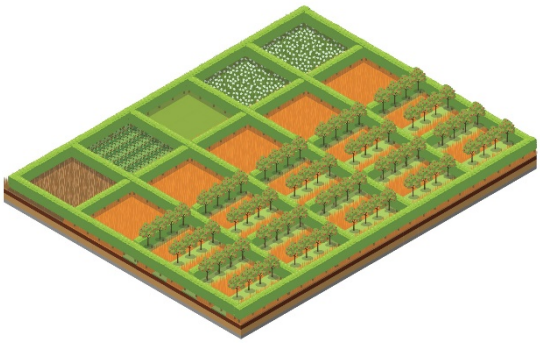


Figure 6.11: Case study cropping farm A, 164 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

The apple cash crop assumed makes agroforestry an attractive option, increasing net profit on the FBS representative farm by £154-318/farm ha (£30-62k/farm), for 5% and 10% tree cover respectively. For Farm A, net profit is increased by £79-203/farm ha (£13-33k/farm). Establishment costs would include both capital investments (ca. £1,500/ha for trees, guards,

fencing and labour) as well as lack of production in the first few years (0% yield in years 1-3, 50% in years 4-5). Further information can be found in the Agroforestry Handbook[52].

Hedge planting could also be an option for agroforestry on some arable farms, though not evaluated here. For hedges, establishment costs can be estimated based on the AECS grant of £5.50/m plus fencing costs of £6.5/m. For a 5 ha field with a 900m boundary, the cost would be £10,800 (£16,650 if double fencing required) or about £2,160 per farm ha (£3,330 if double-fenced). Costs would be reduced proportionately if common boundaries with neighbouring fields on the same farm were planted and fenced.

6.2.7 Habitat conservation

The habitat conservation option assumes that 20% of the farm is taken out of food production and focused on wildlife and ecosystem services. This may be a combination of protecting existing habitats and/or creating new ones, although for both the FBS arable farm and Farm A, the low level of AECS income suggests no significant areas of habitat are present or actively conserved on the farms. For the FBS representative farm, this option involves 40 ha, of which 20 ha was permanent grassland and 20 ha arable crops (Figure 6.12). For Farm A, 33 ha are taken out of production, again about 50% of which was grassland and 50% crops (Figure 6.13). High value crops such as potatoes and vegetables are maintained.

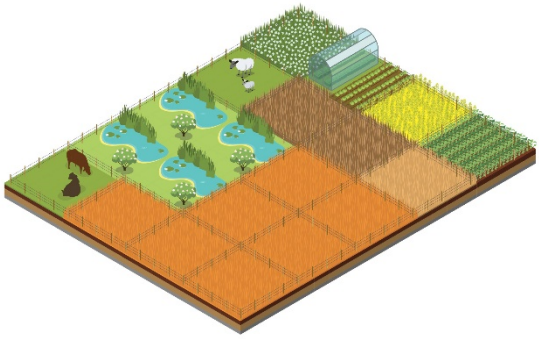


Figure 6.12: FBS representative cropping farm, 194 ha, habitat conservation

Source: own estimates; Key: see Annex 1

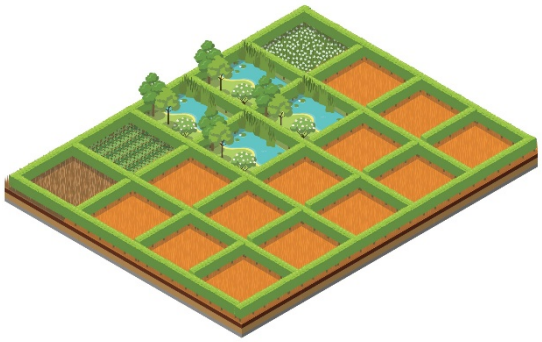


Figure 6.13: Case study cropping farm A, 164 ha, habitat conservation

Source: own estimates; Key: see Annex 1

Net profit on the FBS representative arable farm is reduced by £61/farm ha (£12k/farm). This represents about £300/actual ha taken out of production, and is equivalent to 29% of the baseline basic payments. For Farm A, net profit is reduced by £72/farm ha (£12k/farm), which is equivalent to £360/actual ha taken out of production, and is equivalent to 45% of the baseline basic payments. The relevant AECS habitat options, such as grass strips and water margins in arable fields (£495/ha each) and creation and management of species-rich grassland (£285/ha), indicate these estimates are not unreasonable.

6.2.8 Nature restoration

The nature restoration option is the most radical of all, with 50% of the farm assumed to be taken out of production and allowed to revert to natural conditions with a mix of trees, shrubs and other vegetation. Some groundworks relating to water courses, e.g. blocking drains, may be required to initiate restoration processes. Grassland patches in clearings are maintained with limited browsing by herbivores such as cattle (illustrated but not included in the financial assessment of Farm A due to limited scale). In the arable case, grassland areas and some of the combinable crops are prioritised for restoration, while high value crops are retained. For the FBS representative farm, tillage crops are reduced by 46 ha (Figure 6.14), and on Farm A

[52] *Op cit.* (50)

by 60 ha (Figure 6.15). Net profit on the FBS representative arable farm is reduced by £73/farm ha (£14k/farm). This represents about £146/actual ha taken out of production, and is equivalent to 34% of the baseline basic payments. For Farm A, net profit is reduced by £94/farm ha (£15k/farm), which is equivalent to £188/actual ha taken out of production and 59% of the baseline basic payments. It should be noted that these estimates include an assumed reduction of 25% in fixed costs (£25k/farm for the FBS farm, and £24k/farm for Farm A), which may or may not be realised in practice.

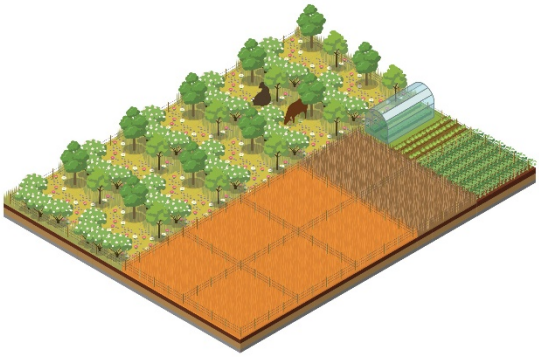


Figure 6.14: FBS representative cropping farm, 194 ha, nature restoration.

Source: own estimates; Key: see Annex 1

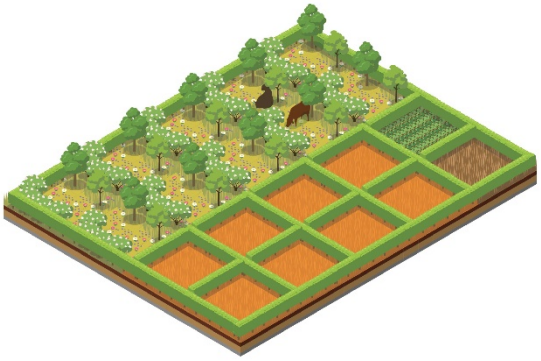


Figure 6.15: Case study cropping farm A, 164 ha, nature restoration

Source: own estimates; Key: see Annex 1

6.3 Dairy farms

For a description of the dairy farm type and case study Farm D, see Section 4.3. The structural and financial characteristics of the baseline models are detailed in Table 6.3 for the FBS representative farm and Table 6.4 for the case study farm. These tables also provide the model results for all options. Commercial forestry and native woodlands already present on the farms are not included in the tables and figures presented.

The FBS representative dairy farm baseline model is 148 ha, of which 6.5 ha are cereals, 28 ha rotational grassland, 104 ha permanent grassland and 9 ha rough grazing (Figure 6.16). In addition to 190 dairy cows, small beef and sheep enterprises are also kept. The representative farm generates a net profit before subsidies of nearly £91k (£617/ha). Support payments add £37k to that, resulting in a total net profit of £128k. The case study dairy Farm D baseline model is 159 ha, of which 9 ha are cereals, 10 ha rotational grassland and 140 ha permanent grassland, stocked with 135 dairy cows (Figure 6.17). Farm D generates a net profit before subsidies of nearly £134k (£836/ha). Support payments add £36k to that, resulting in a total net profit of £170k.

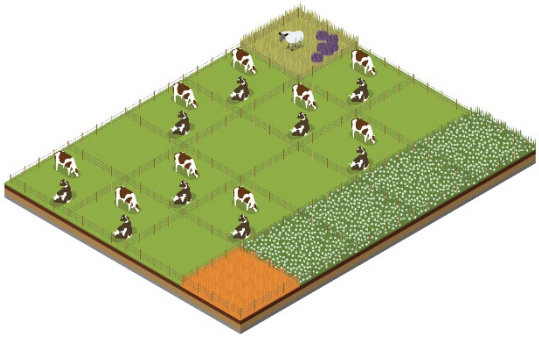


Figure 6.16: FBS representative dairy farm, 148 ha, baseline

Source: own estimates; Key: see Annex 1

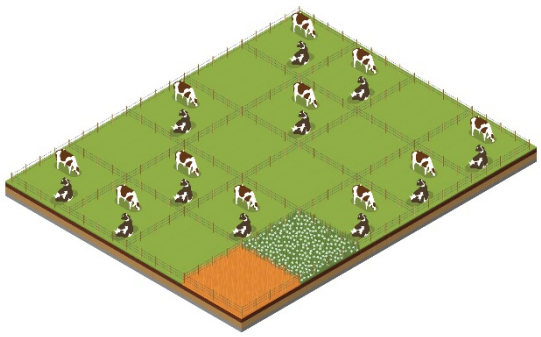


Figure 6.17: Case study dairy farm D, 159 ha, baseline

Source: own estimates; Key: see Annex 1

Table 6.3: Model results for dairy FBS representative farm

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)												
Arable land	6.5	6.5	6.5	6.0	5.7	6.0	5.7	5.1	6.0	5.7	6.5	6.5
Rotational grassland	28.0	28.0	28.0	26.5	25.0	26.5	25	28	26.5	25.0	28	28
Permanent grassland	104.2	104.2	104.2	98.8	93.3	98.8	93.3	104.2	98.8	93.3	83.6	39.3
Rough grazing	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	0.0	0.0
Agroforestry trees/hedge	0	0	0	0	0	0	0	0	7.4	14.7	0	0.0
Uncropped margins	0	0	0	7.4	14.7	7.4	14.7	0	0	0	29.5	73.8
Other	0	0	0	0	0	0	0	0.5	0	1	0.0	0.0
Total area	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6	147.6
Livestock (head)												
dairy (cows)	190	190	190	190	190	190	190	154	190	190	173	104
beef (cows)	2	2	2	2	2	2	2	0	2	2	0	10
sheep (ewes)	33	33	33	33	33	33	33	0	33	33	0	0
Livestock units (LU)	302	302	302	302	302	302	302	244	302	302	268	162
Stocking rate (LU/ha)	2.14	2.14	2.14	2.25	2.38	2.25	2.38	1.72	2.25	2.40	2.40	2.40
Financial data (£/farm)												
Gross margin	295479	297062	298658	295446	295412	297824	299329	262422	297212	296443	266014	168575
dairy (cows)	287584	289020	290456	287584	287583	289020	290455	256910	287584	287583	261853	157414
beef/replacements	4929	4941	4953	4929	4929	4943	4955	4340	4930	4930	3500	10500
sheep	2305	2333	2361	2305	2305	3132	3132	0	3128	3128	0	0
crops	661	768	888	628	595	729	787	1172	1570	802	661	661
Labour	21670	21670	21670	21670	21670	21670	21670	10916	21670	21670	16000	0
Other fixed costs	182676	182676	182676	182676	182676	182676	182676	182676	182676	182676	182676	137007
Net profit (excl. subsidies)	91133	92716	94312	91100	91066	93478	94983	68830	92866	92097	67338	31568
Basic payment	34644	34644	34644	34644	34644	34644	34644	34644	34644	34644	34644	34644
Agri-env payment	2527	2527	2527	2527	2527	2527	2527	2527	2527	2527	2527	2527
Net profit (incl. subsidies)	128304	129887	131483	128271	128237	130649	132154	106001	130037	129268	104509	68739
Financial data (£/farm ha)												
Gross margin	2002	2013	2023	2002	2001	2018	2028	1778	2014	2008	1802	1142
dairy (cows)	1948	1958	1968	1948	1948	1958	1968	1741	1948	1948	1774	1066
beef/replacements	33	33	34	33	33	33	34	29	33	33	24	71
sheep	16	16	16	16	16	21	21	0	21	21	0	0
crops	4	5	6	4	4	5	5	8	11	5	4	4
Labour	147	147	147	147	147	147	147	74	147	147	108	0
Fixed costs	1238	1238	1238	1238	1238	1238	1238	1238	1238	1238	1238	928
Net profit (excl. subsidies)	617	628	639	617	617	633	644	466	629	624	456	214
Basic payment	235	235	235	235	235	235	235	235	235	235	235	235
Agri-env payment	17	17	17	17	17	17	17	17	17	17	17	17
Net profit (incl. subsidies)	869	880	891	869	869	885	895	718	881	876	708	466
Difference compared with baseline (£/farm)												
Gross margin	0	1583	3179	-33	-67	2345	3850	-33057	1733	964	-29465	-126904
dairy (cows)	0	1436	2872	0	-1	1436	2871	-30674	0	-1	-25731	-130170
beef/replacements	0	12	24	0	0	14	26	-589	1	1	-1429	5571
sheep	0	28	56	0	0	827	827	-2305	823	823	-2305	-2305
crops	0	107	227	-33	-66	68	126	511	909	141	0	0
Labour	0	0	0	0	0	0	0	10754	0	0	5670	21670
Other fixed costs	0	0	0	0	0	0	0	0	0	0	0	45669
Net profit (excl. subsidies)	0	1583	3179	-33	-67	2345	3850	-22303	1733	964	-23795	-59565
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	1583	3179	-33	-67	2345	3850	-22303	1733	964	-23795	-59565
Difference compared with baseline (£/farm ha)												
Gross margin	0.0	10.7	21.5	-0.2	-0.5	15.9	26.1	-224	11.7	6.5	-199.6	-859.8
dairy (cows)	0.0	9.7	19.5	0.0	0.0	9.7	19.5	-208	0.0	0.0	-174.3	-881.9
beef/replacements	0.0	0.1	0.2	0.0	0.0	0.1	0.2	-4	0.0	0.0	-9.7	37.7
sheep	0.0	0.2	0.4	0.0	0.0	5.6	5.6	-16	5.6	5.6	-15.6	-15.6
crops	0.0	0.7	1.5	-0.2	-0.4	0.5	0.9	3	6.2	1.0	0.0	0.0
Labour	0.0	0.0	0.0	0.0	0.0	0.0	0.0	73	0.0	0.0	38.4	146.8
Fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	309.4
Net profit (excl. subsidies)	0.0	10.7	21.5	-0.2	-0.5	15.9	26.1	-151	11.7	6.5	-161.2	-403.6
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	10.7	21.5	-0.2	-0.5	15.9	26.1	-151	11.7	6.5	-161.2	-403.6

Table 6.4: Model results for dairy case study Farm D

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)												
Arable land	9.0	9.0	9.0	8.6	8.1	8.6	8.1	0.0	8.6	8.1	9.0	9.0
Rotational grassland	9.8	9.8	9.8	9.3	8.8	9.3	8.8	18.8	9.3	8.8	9.8	9.8
Permanent grassland	140.0	140.0	140.0	132.7	126.2	132.7	126.2	140.0	132.7	126.2	108.2	60.6
Rough grazing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agroforestry trees/hedge	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	15.7	0.0	0.0
Uncropped margins	0.0	0.0	0.0	8.2	15.7	8.2	15.7	0.0	0.0	0.0	31.8	79.4
Total area	158.8	158.8	158.8	158.8	158.8	158.8	158.8	158.8	158.8	158.8	158.8	158.8
Livestock (head)												
dairy (cows)	135	135	135	135	135	135	135	115	135	135	118	70
Livestock unit	196	196	196	196	196	196	196	167	196	196	171	102
Stocking rate	1.31	1.31	1.31	1.38	1.45	1.38	1.45	1.05	1.38	1.45	1.45	1.45
Financial data (£/farm)												
Gross margin	183255	184031	184807	182998	182741	183774	184293	171005	183071	182887	160679	69032
dairy	178119	178895	179671	178119	178119	178895	179671	171005	178119	178119	155543	63896
crops	5136	5136	5136	4879	4622	4879	4622	0	4952	4768	5136	5136
Fixed costs	48939	48939	48939	48939	48939	48939	48939	48939	48939	48939	48939	36704
Net profit (excl. subsidies)	134316	135092	135868	134059	133802	134835	135354	122066	134132	133948	111740	32328
Basic Payment Scheme	35583	35583	35583	35583	35583	35583	35583	35583	35583	35583	35583	35583
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	169899	170675	171451	169642	169385	170418	170937	157649	169715	169531	147323	67911
Financial data (£/farm ha)												
Gross margin	1154	1159	1164	1152	1151	1157	1161	1077	1153	1152	1012	435
dairy	1122	1127	1131	1122	1122	1127	1131	1077	1122	1122	979	402
crops	32	32	32	31	29	31	29	0	31	30	32	32
Fixed costs	308	308	308	308	308	308	308	308	308	308	308	231
Net profit (excl. subsidies)	846	851	856	844	843	849	852	769	845	844	704	204
Basic payment	224	224	224	224	224	224	224	224	224	224	224	224
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	1070	1075	1080	1068	1067	1073	1076	993	1069	1068	928	428
Difference compared with baseline (£/farm)												
Gross margin	0	776	1552	-257	-514	519	1038	-12250	-184	-368	-22576	-114223
dairy	0	776	1552	0	0	776	1552	-7114	0	0	-22576	-114223
crops	0	0	0	-257	-514	-257	-514	-5136	-184	-368	0	0
Fixed costs	0	0	0	0	0	0	0	0	0	0	0	-12235
Net profit (excl. subsidies)	0	776	1552	-257	-514	519	1038	-12250	-184	-368	-22576	-101988
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	776	1552	-257	-514	519	1038	-12250	-184	-368	-22576	-101988
Difference compared with baseline (£/farm ha)												
Gross margin	0.0	4.9	9.8	-1.6	-3.2	3.3	6.5	-77.1	-1.2	-2.3	-142.2	-719.3
dairy	0.0	4.9	9.8	0.0	0.0	4.9	9.8	-44.8	0.0	0.0	-142.2	-719.3
crops	0.0	0.0	0.0	-1.6	-3.2	-1.6	-3.2	-32.3	-1.2	-2.3	0.0	0.0
Fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-77.0
Net profit (excl. subsidies)	0.0	4.9	9.8	-1.6	-3.2	3.3	6.5	-77.1	-1.2	-2.3	-142.2	-642.2
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	4.9	9.8	-1.6	-3.2	3.3	6.5	-77.1	-1.2	-2.3	-142.2	-642.2

6.3.1 Reduced agrochemical inputs and increased input use efficiency

Two versions of this option have been analysed, involving 10% and 20% reductions in input use, with crop yields and livestock numbers maintained as a result of improved efficiency. Cropped areas and fixed costs are assumed to remain constant. For the FBS representative farm, gross margins increase by ca. £11/farm ha (£1,600/farm) for each 10% reduction in input use, due to the improvement in production efficiency. For Farm D, gross margins were estimated to increase by £5/farm ha (£800/farm) for each 10% reduction in input use.

Although the benefits are not as great as for the arable farms, the potential win-win for farm profits and the environment with this option suggest public support should be focused on information and advisory support and planning tools, to encourage greater uptake.

6.3.2 Environmental set-aside

Two versions of this option have been analysed, involving 5% and 10% of land area designated primarily for wildlife and ecosystem service provision. These are similar to the current policies for 5% ecological focus areas as part of Greening and, in the 10% case, at least 6m uncropped field margins. In some cases, less productive land may be set aside, or production levels (livestock numbers) on the remaining land intensified (by increasing fertiliser use or purchased feed inputs, or by reducing replacement rates), so that total output may be maintained. This is assumed to the case for dairying, with stocking rates increasing by about 0.1 LU/forage ha for each 5% set aside. It should be noted that livestock numbers in the baseline models are already reduced due to projected market conditions compared with the actual numbers recorded in 2017/18 (see Chapter 4).

For the FBS representative farm (Figure 6.18), net profit (before support payments) is reduced by a negligible £33/farm for each 5% set aside. Farm D results (Figure 6.19) indicate a higher but still modest reduction of £257/farm for each 5% set-aside. Under the current AECS, the £123/ha water margin in grassland option gives an alternative estimate for the financial impact of this measure, which is still relatively low.

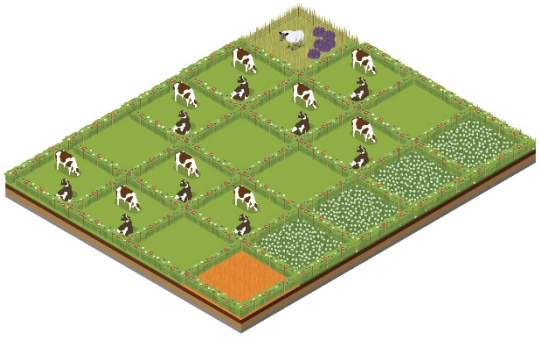


Figure 6.18: FBS representative dairy farm, 148 ha, uncropped field margins

Source: own estimates; Key: see Annex 1

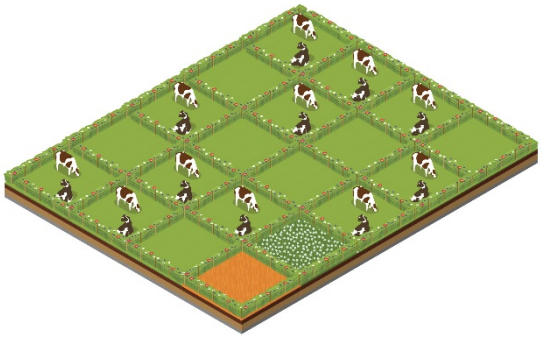


Figure 6.19: Case study dairy farm D, 159 ha, uncropped field margins

Source: own estimates; Key: see Annex 1

6.3.3 Options 1 and 2 combined

The above two options could be combined on the same field, with one focused on the field margins and the other focused on the cropped land. For the FBS representative dairy farm, this would result in a net profit *increase* of about £16/farm ha (£2k/farm) with 5% set-aside and 10% input reduction or £26/farm ha (£4k/farm) with 10% set-aside and 20% input reduction. For Farm D, there is a smaller increase, ranging from £500 to £1,000 per farm.

6.3.4 Conservation agriculture

This option is not applicable to this farm type.

6.3.5 Organic farming

Organic farming on dairy farms requires the use of white clover and other legumes in grassland to replace synthetic nitrogen fertilisers. Reseeding to achieve this can increase the proportion of rotational grassland relative to permanent. Stocking rates per forage ha are estimated to be 20% lower than under non-organic management, in part due to not using

nitrogen fertiliser, but also due to reduced reliance on purchased (organic) concentrates. On the FBS representative farm (Figure 6.20), cows numbers are reduced from 190 to 154, while on Farm D (Figure 6.21) cow numbers fall from 135 to 115. Given the investments in buildings and dairy facilities, there is often pressure to maintain cow numbers at the expense of diversification into other livestock types or crop production.

Premium prices for organic milk production can, in some circumstances, be high enough to balance the reduced stocking and higher feed prices. This is not so in this analysis due to the price projections used in the model. On the FBS representative farm, net profit before subsidies is reduced by £150/farm ha (£22k/farm). For Farm D, net profit is estimated to fall by £77/farm ha (£12k/farm). There is also a need to consider the conversion (establishment) costs associated with reseeding grassland and establishing legumes, and the lack of access to premium prices during the conversion period, which for dairy farms may be worth more than £600/ha. The current AECS organic options provide a higher rate conversion payment (first two years only) of: arable £280/ha, improved grass £140/ha and rough grazing £12.50/ha. For subsequent maintenance the rates are: arable £65/ha, improved grass £55/ha and rough grazing £8.50/ha. These values are somewhat lower than the model estimates for dairy farms.

There may be scope for this option to be combined with other options (e.g. agroforestry, habitat conservation and nature regeneration) but these possible combinations have not been analysed separately. The case for combination with environmental set-aside is less convincing, due to the reductions in input use and increased environmental benefits on a whole field basis.

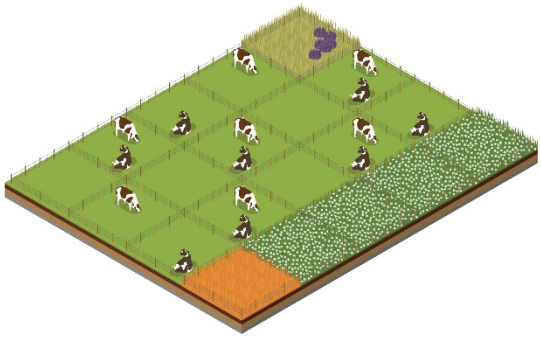


Figure 6.20: FBS representative dairy farm, 148 ha, organic farming

Source: own estimates; Key: see Annex 1

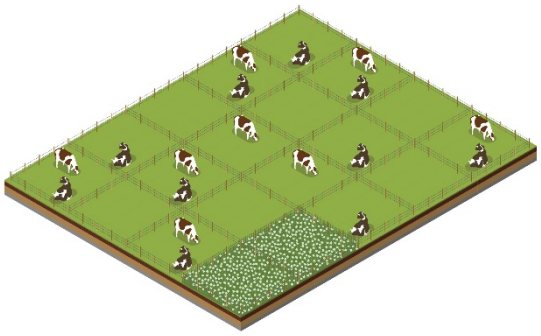


Figure 6.21: Case study dairy farm D, 159 ha, organic farming

Source: own estimates; Key: see Annex 1

6.3.6 Agroforestry

Two agroforestry options have been evaluated involving 5% or 10% of land being occupied by trees. In the dairy case, on the assumption that many (if not most) dairy farms have limited hedgerows, and that there is a need to limit trees in field for grazing and forage conservation purposes, the focus is on establishing hedgerows using appropriate species, including trees at intervals. Unlike the arable situation, the agroforestry component is unlikely to generate any income, at least in the short to medium term. A tightly-managed hedge on all fields would occupy about 5% of available land, broader hedgerows and additional tree planting could take up 10% of land area.

For the FBS representative dairy farm (Figure 6.22), the reduction in net profit is estimated at £2k/farm for the 5% cover option and £1k/farm for the 10% cover option. The reduction in loss is a consequence of a reduced land area receiving fertiliser while maintaining stocking rates. For Farm D (Figure 6.23), the reduction is negligible at less than £200/farm for the 5% option and less than £400/farm for the 10% option. In both cases, the loss of land to trees is

compensated by higher stocking rates, for similar reasons to the environmental set-aside options discussed above. The establishment costs can be estimated based on the AECS grant of £5.50/m for hedgerow planting, plus £6.50/m for fencing. For a 5 ha field with a 900m boundary, the cost would be £10,800 (£16,650 if double fencing required) or about £2,160 per farm ha (£3,330 if double-fenced). Costs would be reduced proportionately if common boundaries with neighbouring fields were planted and fenced.

Figure 6.22: FBS representative dairy farm, 148 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

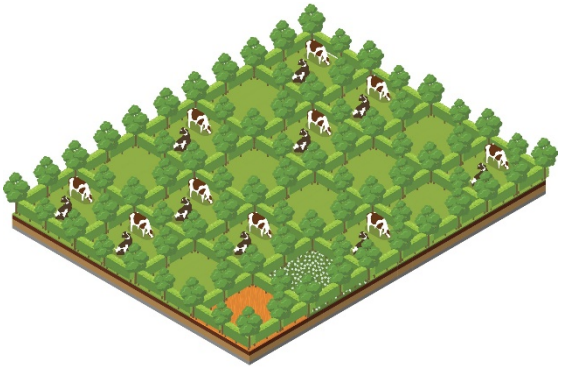


Figure 6.23: Case study dairy farm D, 159 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

6.3.7 Habitat conservation

The habitat conservation option assumes that 20% of the farm is taken out of food production and focused on wildlife and ecosystem services. This may be a combination of protecting existing habitats or creating new ones, although for both the FBS dairy farm and Farm D, the low level of AECS income suggests no significant areas of habitat are present or actively conserved on the farms. For the FBS representative farm, this involves just under 30 ha less permanent grassland, with stocking reduced from 190 to 173 cows (Figure 6.24). For Farm D, 32 ha of permanent grassland are taken out of production and stocking reduced from 135 to 118 cows (Figure 6.25).

Net profit on the FBS representative dairy farm is reduced by £161/farm ha (£24k/farm). This represents about £800/actual ha taken out of production, and 69% of the baseline basic payments. For Farm D, net profit is reduced by £142/farm ha (£23k/farm), which is equivalent to £700/actual ha taken out of production and 63% of the baseline basic payments. As such the impacts are much greater than on arable farms. They are also higher than the £285/ha for AECS creation and management of species rich grassland options. This reflects the much higher value of dairy production compared with other grazing livestock enterprises.

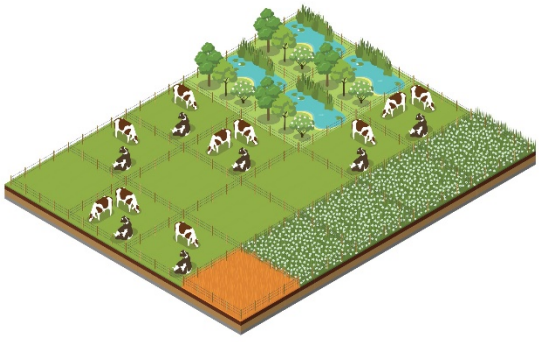


Figure 6.24: FBS representative dairy farm, 148 ha, habitat conservation

Source: own estimates; Key: see Annex 1

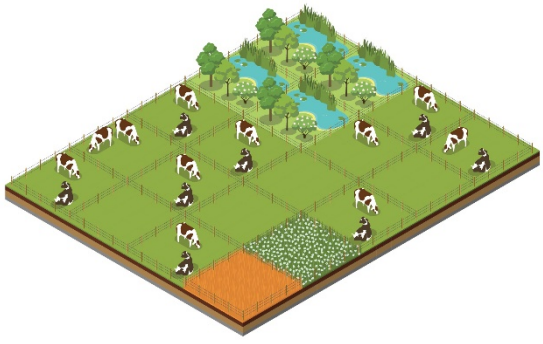


Figure 6.25: Case study dairy farm D, 159 ha, habitat conservation

Source: own estimates; Key: see Annex 1

6.3.8 Nature restoration

The nature restoration option is the most radical of all, with 50% of the farm assumed to be taken out of production and allowed to revert to natural conditions with a mix of trees, shrubs and other vegetation. Some groundworks relating to water courses, e.g. blocking drains, may be required to initiate restoration processes. Grassland patches in clearings are maintained with limited browsing by herbivores such as cattle – we have assumed suckler cows in the case of the FBS representative farm and replacements or dry cows in the Farm D case. In the dairy case, grassland areas are prioritised for restoration. Dairy cow numbers are reduced by almost 50%, from 190 to 104 cows on the FBS representative farm (Figure 6.26) and from 135 to 70 cows on Farm D (Figure 6.27).

Net profit on the FBS representative dairy farm is reduced by £400/farm ha (£60k/farm). This represents about £800/actual ha taken out of production, and 172% of the baseline basic payments. For Farm D, net profit is reduced by £642/farm ha (£102k/farm), which is equivalent to £1,284/ha taken out of production and 287% of the baseline basic payments. These very high negative impacts are despite the assumed reduction of 25% in fixed costs (£67k/farm for the FBS farm, and £12k/farm for Farm D), which may or may not be realised in practice.

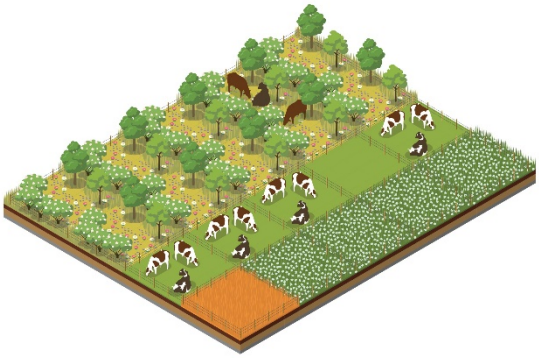


Figure 6.26: FBS representative dairy farm, 148 ha, nature restoration

Source: own estimates; Key: see Annex 1

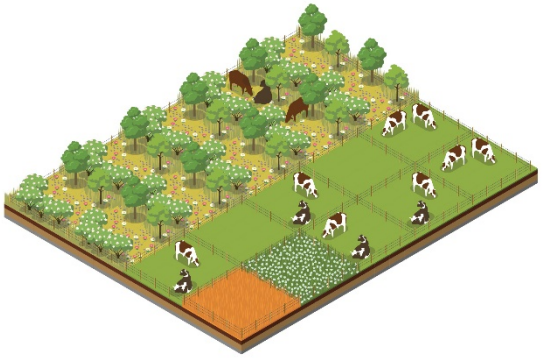


Figure 6.27: Case study dairy farm D, 159 ha, nature restoration

Source: own estimates; Key: see Annex 1

6.4 Lowland livestock

For a description of the lowland livestock farm type and case study Farm L, see Section 4.4. The structural and financial characteristics of the baseline models are detailed in Table 6.5 for the FBS representative farm and Table 6.6 for the case study farm. These tables also provide the model results for all options. Commercial forestry and native woodlands already present on the farms are not included in the tables and figures presented.

The FBS representative lowland livestock farm baseline model is 148 ha, of which about 10 ha are cereals and fodder crops, 30 ha rotational grassland, 123 ha improved permanent grassland and 15 ha rough grazing (Figure 6.28). 80 suckler beef cows plus finishers and 89 ewes are kept. The representative farm generates a net loss before subsidies of nearly £31k (£207/ha). Support payments add £54k to that, resulting in a total net profit of £24k.

The case study lowland livestock Farm L baseline model is 113 ha, with a more substantial arable component including 27 ha of cereals and 6 ha fodder crops (Figure 6.29). There are 81 ha of grassland, split 50:50 permanent and rotational, on which 81 suckler cows and 148 ewes are kept. Farm L generates a net profit before subsidies of nearly £7k (£60/ha). Support payments add £25k to that, resulting in a total net profit of £31k. Farm L has an area of commercial woodland which has not been included in the analysis or illustrations.

Table 6.5: Model results for lowland livestock FBS representative farm

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)												
Cereals	6.2	6.2	6.2	6.1	6.2	6.1	6.2	5.5	6.1	6.2	6.2	6.2
Fodder crops	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	1.2	1.2
Rotational grassland	30.0	30.0	30.0	28.6	26.8	28.6	26.8	30.7	28.6	26.8	30.0	30.0
Permanent grassland	93.0	93.0	93.0	88.4	83.2	88.4	83.2	93.0	88.4	83.2	80.8	36.4
Rough grazing	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	0.0	0.0
Agroforestry trees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	13.0	0.0	0.0
Uncropped margins	0.0	0.0	0.0	6.1	13.0	6.1	13.0	0.0	0.0	0.0	29.5	73.9
Total	147.7	147.7	147.7	147.7	147.7	147.7	147.7	147.7	147.7	147.7	147.7	147.7
Livestock (head)												
beef	80	80	80	80	80	80	80	64	80	80	74	55
sheep	89	89	89	89	89	89	89	71	89	89	82	61
Livestock units (LU)	135	135	135	135	135	135	135	108	135	135	125	92
Stocking rate (LU/ha)	0.98	0.98	0.98	1.02	1.08	1.02	1.08	0.78	1.02	1.08	1.13	1.13
Financial data (£/farm)												
Gross margin	37004	37233	37524	36937	36921	37372	37469	31604	37880	37145	34313	25360
beef	30462	30610	30771	30461	30461	30771	30771	25743	30462	30462	28206	20759
sheep	6164	6184	6204	6164	6164	6184	6204	5103	6164	6164	5707	4201
crops	378	439	549	312	296	417	494	758	1254	519	400	400
Labour costs	370	305	305	370	322	233	305	411	322	322	300	0
Other fixed costs	67233	67233	67233	67233	67233	67233	67233	67233	67233	67233	67233	50425
Net profit (excl. subsidies)	-30599	-30305	-30014	-30666	-30634	-30094	-30069	-36040	-29675	-30410	-33220	-25065
Basic payment	44960	44960	44960	44960	44960	44960	44960	44960	44960	44960	44960	44960
Agri-env payment	9419	9419	9419	9419	9419	9419	9419	9419	9419	9419	9419	9419
Net profit (incl. subsidies)	23780	24074	24365	23713	23745	24285	24310	18339	24704	23969	21159	29314
Financial data (£/farm ha)												
Gross margin	251	252	254	250	250	253	254	214	256	251	232	172
beef	206	207	208	206	206	208	208	174	206	206	191	141
sheep	42	42	42	42	42	42	42	35	42	42	39	28
crops	3	3	4	2	2	3	3	5	8	4	3	3
Labour costs	3	2	2	3	2	2	2	3	2	2	2	0
Other fixed costs	455	455	455	455	455	455	455	455	455	455	455	342
Net profit (excl. subsidies)	-207	-205	-203	-208	-207	-204	-204	-244	-201	-206	-225	-170
Basic payment	304	304	304	304	304	304	304	304	304	304	304	305
Agri-env payment	64	64	64	64	64	64	64	64	64	64	64	64
Net profit (incl. subsidies)	161	163	165	161	161	164	165	124	167	162	143	199
Difference compared with baseline (£/farm)												
Gross margin	0	229	520	-67	-83	368	465	-5400	876	141	-2691	-11644
beef	0	148	309	-1	-1	309	309	-4719	0	0	-2256	-9703
sheep	0	20	40	0	0	20	40	-1061	0	0	-457	-1963
crops	0	61	171	-66	-82	39	116	380	876	141	22	22
Labour costs	0	-65	-65	0	-48	-137	-65	41	-48	-48	-70	-370
Other fixed costs	0	0	0	0	0	0	0	0	0	0	0	-16808
Net profit (excl. subsidies)	0	294	585	-67	-35	505	530	-5441	924	189	-2621	5534
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	294	585	-67	-35	505	530	-5441	924	189	-2621	5534
Difference compared with baseline (£/farm ha)												
Gross margin	0.0	1.6	3.5	-0.5	-0.6	2.5	3.1	-36.6	5.9	1.0	-18.3	-78.8
beef	0.0	1.0	2.1	0.0	0.0	2.1	2.1	-31.9	0.0	0.0	-15.3	-65.6
sheep	0.0	0.1	0.3	0.0	0.0	0.1	0.3	-7.2	0.0	0.0	-3.1	-13.3
crops	0.0	0.4	1.2	-0.4	-0.6	0.3	0.8	2.6	5.9	1.0	0.1	0.1
Labour costs	0.0	-0.4	-0.4	0.0	-0.3	-0.9	-0.4	0.3	-0.3	-0.3	-0.5	-2.5
Other fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-113.7
Net profit (excl. subsidies)	0.0	2.0	4.0	-0.5	-0.2	3.4	3.6	-36.8	6.3	1.3	-17.7	37.4
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.1
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	2.0	4.0	-0.5	-0.2	3.4	3.6	-36.8	6.3	1.3	-17.8	37.5

Table 6.6: Model results for lowland livestock case study Farm L

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)												
Cereals	26.6	26.6	26.6	25.2	23.9	25.3	23.9	21.4	26.6	26.6	22.7	22.7
Fodder crops	6.0	6.0	6.0	5.7	5.4	5.7	5.4	6.0	6.0	6.0	0.0	0.0
Rotational grassland	40.5	40.5	40.5	38.5	36.5	38.4	36.5	45.7	40.5	40.5	40.5	34.0
Permanent grassland	39.5	39.5	39.5	37.5	35.6	37.5	35.6	39.5	33.8	28.2	27.5	0.0
Rough grazing	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0	0.0
Agroforestry trees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	11.3	0.0	0.0
Uncropped margins	0.0	0.0	0.0	5.7	11.3	5.7	11.3	0.0	0.0	0.0	22.7	56.7
Total	113.4	113.4	113.4	113.4	113.4	113.4	113.4	113.4	113.4	113.4	113.4	113.4
Livestock (head)												
beef	81	81	81	81	81	81	81	69	81	81	77	53
sheep	148	148	148	148	148	148	148	128	148	148	141	80
Livestock units (LU)	135	135	135	135	135	135	135	115	135	135	128.8	86.2
Stocking rate (LU/for.ha)	1.67	1.67	1.67	1.76	1.86	1.76	1.85	1.34	1.77	1.87	1.89	1.90
Financial data (£/farm)												
Gross margin	76930	79199	81502	76535	76192	78781	80518	71609	76751	77054	72415	50372
beef	58415	59208	60032	58384	58384	59208	60032	51430	58384	58384	55494	38222
sheep	11651	11648	11648	11631	11631	11648	11647	10060	11631	11631	11068	6298
crops	6864	8343	9822	6520	6177	7925	8839	10119	6736	7039	5852	5852
Fixed costs	70092	70092	70092	70092	70092	70092	70092	70092	70092	70092	70092	52569
Net profit (excl. subsidies)	6838	9107	11410	6443	6100	8689	10426	1517	6659	6962	2323	-2197
Basic Payment Scheme	18525	18525	18525	18525	18525	18525	18525	18525	18525	18525	18525	18525
Agri-env payment	6120	6120	6120	6120	6120	6120	6120	6120	6120	6120	6120	6120
Net profit (incl. subsidies)	31483	33752	36055	31088	30745	33334	35071	26162	31304	31607	26968	22448
Financial data (£/farm ha)												
Gross margin	678	698	719	675	672	695	710	631	677	679	639	444
beef	515	522	529	515	515	522	529	454	515	515	489	337
sheep	103	103	103	103	103	103	103	89	103	103	98	56
crops	61	74	87	58	54	70	78	89	59	62	52	52
Fixed costs	618	618	618	618	618	618	618	618	618	618	618	464
Net profit (excl. subsidies)	60	80	101	57	54	77	92	13	59	61	20	-19
Basic Payment Scheme	163	163	163	163	163	163	163	163	163	163	163	163
Agri-env payment	54	54	54	54	54	54	54	54	54	54	54	54
Net profit (incl. subsidies)	278	298	318	274	271	294	309	231	276	279	238	198
Difference compared with baseline (£/farm)												
Gross margin	0	2269	4572	-395	-738	1851	3588	-5321	-179	124	-4515	-26558
beef	0	793	1617	-31	-31	793	1617	-6985	-31	-31	-2921	-20193
sheep	0	-3	-3	-20	-20	-3	-4	-1591	-20	-20	-583	-5353
crops	0	1479	2958	-344	-687	1061	1975	3255	-128	175	-1012	-1012
Fixed costs	0	0	0	0	0	0	0	0	0	0	0	-17523
Net profit (excl. subsidies)	0	2269	4572	-395	-738	1851	3588	-5321	-179	124	-4515	-9035
Basic Payment Scheme	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	2269	4572	-395	-738	1851	3588	-5321	-179	124	-4515	-9035
Difference compared with baseline (£/farm ha)												
Gross margin	0.0	20.0	40.3	-3.3	-6.4	16.5	31.4	-46.9	-1.4	1.1	-39.8	-234.2
beef	0.0	7.0	14.3	-0.1	-0.2	7.1	14.1	-61.6	-0.1	-0.3	-25.8	-178.1
sheep	0.0	0.0	0.0	-0.1	-0.2	0.0	-0.1	-14.0	-0.1	-0.2	-5.1	-47.2
crops	0.0	13.0	26.1	-3.0	-6.1	9.4	17.4	28.7	-1.1	1.5	-8.9	-8.9
Fixed costs	0.0	0.0	0.0	0.2	0.1	0.2	-0.2	0.0	0.2	0.0	0.0	-154.5
Net profit (excl. subsidies)	0.0	20.0	40.3	-3.5	-6.5	16.3	31.6	-46.9	-1.6	1.1	-39.8	-79.7
Basic Payment Scheme	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	20.0	40.3	-3.4	-6.5	16.4	31.5	-46.9	-1.5	1.1	-39.8	-79.7

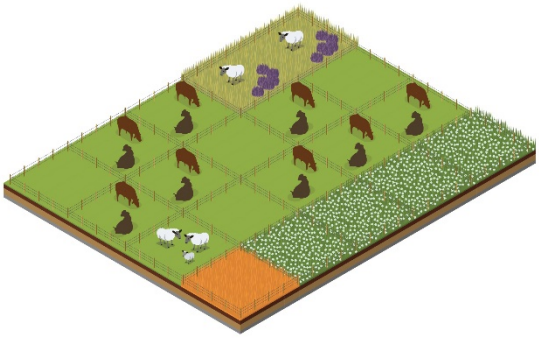


Figure 6.28: FBS representative livestock farm, 148 ha, baseline

Source: own estimates; Key: see Annex 1

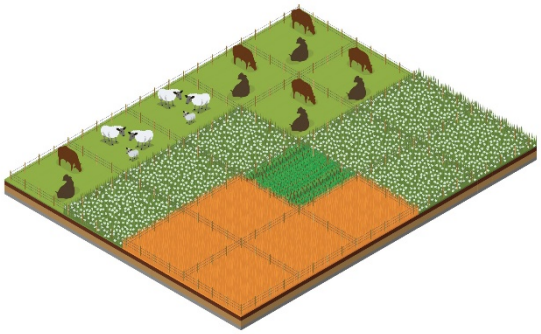


Figure 6.29: Case study livestock farm L, 113 ha, baseline

Source: own estimates; Key: see Annex 1

6.4.1 Reduced agrochemical inputs and increased input use efficiency

Two versions of this option have been analysed, involving 10% and 20% reductions in input use, with crop yields and livestock numbers maintained as a result of improved efficiency. Cropped areas and fixed costs are assumed to remain constant. For the FBS representative farm, net profits are estimated to increase by a negligible £2/farm ha (£294/farm) for each 10% reduction in input use, due to the improvement in production efficiency. For Farm L, net profit was estimated to increase more substantially, by £20/farm ha (£2.3k/farm) for each 10% reduction in input use. As with dairy, the potential win-win for farm profits (though modest) and the environment with this option suggest public support should be focused on information and advisory support and planning tools, to encourage greater uptake.

6.4.2 Environmental set-aside

Two versions of this option have been analysed, involving 5% and 10% of land area designated primarily for wildlife and ecosystem service provision. These are similar to the current policies for 5% ecological focus areas as part of Greening and, in the 10% case, at least 6m uncropped field margins. In some cases, less productive land may be set-aside, or production levels (livestock numbers) on the remaining land intensified, so that total output may be maintained. This is assumed to be the case for lowland livestock, with stocking rates increasing by up to 0.1 LU/forage ha for each 5% set aside. For the FBS representative farm (Figure 6.30), net profit (before support payments) is reduced by a negligible £35 to £67/farm. Farm L (Figure 6.31) results indicate £400/farm net profit reduction for each 5%, equivalent to £70/actual ha set aside. Under the current AECS, the £123/ha water margin in grassland option gives an alternative estimate for the financial impact of this measure, which is still relatively low.

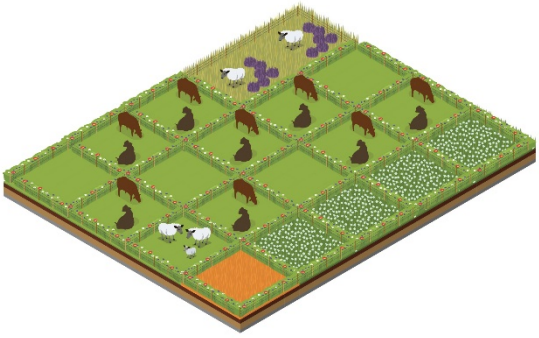


Figure 6.30: FBS representative livestock farm, 148 ha, uncropped field margins

Source: own estimates; Key: see Annex 1

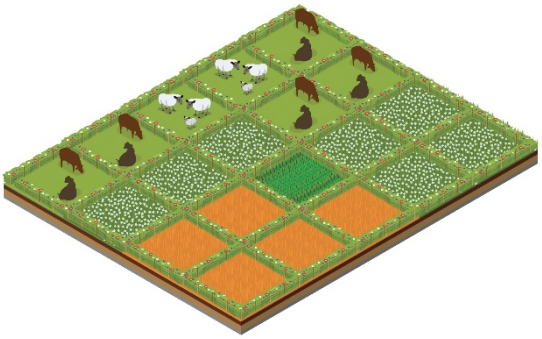


Figure 6.31: Case study livestock farm L, 113 ha, uncropped field margins

Source: own estimates; Key: see Annex 1

6.4.3 Options 1 and 2 combined

The above two options could be combined on the same field, with one focused on the field margins and the other focused on the cropped land. For the FBS representative lowland livestock farm, this would result in a net profit increase of about £3.50/farm ha (£500/farm) for both variants. For Farm L, the 5% set-aside and 10% reduced input combination resulted in a net profit increase of £16/farm ha (£2k/farm), and £32/farm ha (£4k/farm) for the 10% set-aside, 20% input reduction combination.

6.4.4 Conservation agriculture

This option is not applicable to this farm type.

6.4.5 Organic farming

Organic farming on livestock farms requires the use of white clover and other legumes in grassland to replace synthetic nitrogen fertilisers. Reseeding to achieve this can increase the proportion of rotational grassland relative to permanent, although slot seeding and other techniques may be used to enhance clover content in permanent swards. Stocking rates per forage ha are estimated to be 20% lower than under non-organic management, in part due to not using nitrogen fertiliser, but also due to reduced reliance on purchased (organic) concentrates. On the FBS representative farm (Figure 6.32), beef cow numbers are reduced from 80 to 64 and ewe numbers from 89 to 71. On Farm L (Figure 6.33), beef cow numbers fall from 81 to 69 and ewe numbers from 148 to 128. The pressure to maintain livestock numbers on these farms is not as great as on dairy farms.

Although crop yields and livestock numbers are reduced under organic management, premium prices for organic food and lower input costs compensate, often generating higher gross margins per ha. However, for beef and sheep price premiums are typically low or negligible. On the FBS representative farm, net profit before subsidies is estimated to fall by £37/farm ha (£5k/farm). For Farm L, net profit is estimated to fall by £47/farm ha (£5k/farm). There is also a need to consider the conversion (establishment) costs associated with restructuring farming enterprises and the lack of access to premium prices during the conversion period, although this is less significant on non-dairy grazing livestock farms. The current AECS organic options provide for a higher rate conversion payment (first two years only) of: arable £280/ha, improved grass £140/ha and rough grazing £12.50/ha. For subsequent maintenance the rates are: arable £65/ha, improved grass £55/ha and rough grazing £8.50/ha. These values are not inconsistent with the model estimates.

There may be scope for this option to be combined with other options (e.g. agroforestry, habitat conservation and nature regeneration) but these possible combinations have not been analysed separately. The case for combination with environmental set-aside is less convincing, due to the reductions in input use and increased environmental benefits on a whole field basis.

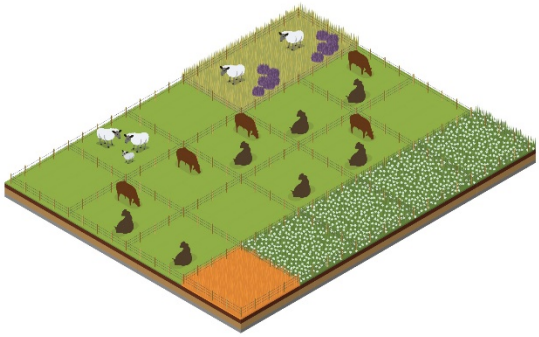


Figure 6.32: FBS representative livestock farm, 148 ha, organic farming

Source: own estimates; Key: see Annex 1

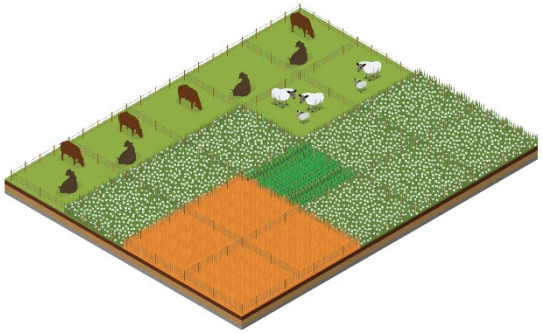


Figure 6.33: Case study livestock farm L, 113 ha, organic farming

Source: own estimates; Key: see Annex 1

6.4.6 Agroforestry

Two agroforestry options have been evaluated involving 5% or 10% of land being occupied by trees. In the lowland livestock case, this is primarily based the introduction of individual trees in permanent grassland in a parkland approach. Although Farm L has a separate commercial forestry option (not illustrated), the agroforestry would be independent of this. The two uptake rates analysed reflect different tree densities of 50 and 100 trees per ha. It would also be relevant to consider the introduction of hedges on farms where hedges are absent or limited (as in the dairy case), but this has not been analysed for lowland livestock.

For the FBS representative farm (Figure 6.34), increased net profits up to £1,000 per farm are estimated. For Farm L (Figure 6.35), a negligible impact is estimated. Establishment costs of £5k to £10k per ha need to be considered – costs vary depending on the tree protection measures implemented. The current AECS capital grant scheme for small scale farm woodlands may be relevant in this context, providing £2,400/ha for creation and £400/ha for maintenance, although it is more focused on shelterbelts etc. than scattered individual trees.

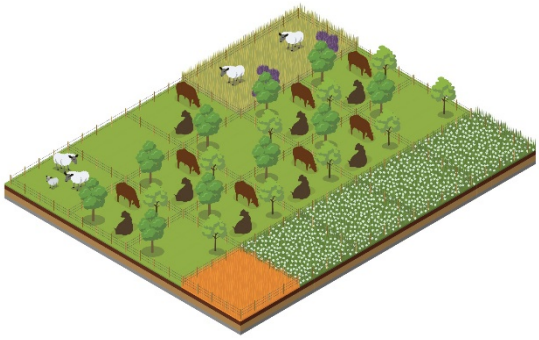


Figure 6.34: FBS representative livestock farm, 148 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

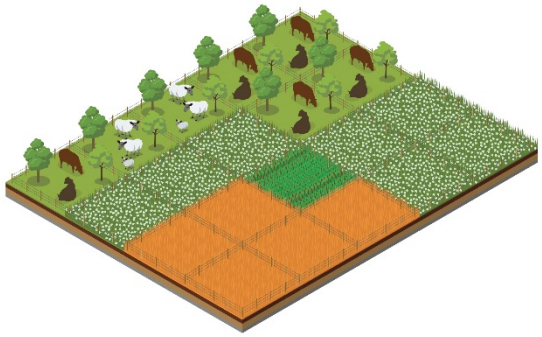


Figure 6.35: Case study livestock farm L, 113 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

6.4.7 Habitat conservation

The habitat conservation option assumes that 20% of the farm is taken out of food production and focused on wildlife and ecosystem services. This may be a combination of protecting existing habitats or creating new ones – the level of AECS income on lowland livestock farms suggest only a modest area of habitat is already present or actively conserved. For the FBS representative farm, the option involves 30 ha of permanent grassland and rough grazing are taken out of production, with stock numbers reduced from 135 to 125 LU (Figure 6.36). For Farm L, 23 ha of permanent grassland are taken out of production and stock numbers reduced

from 135 to 129 LU (Figure 6.37). Net profit on the FBS representative lowland livestock farm is reduced by £18/farm ha (£3k/farm). This represents about £90/actual ha taken out of production, and 6% of the baseline basic payments. For Farm L, net profit is reduced by £40/farm ha (£4,500/farm), which is equivalent to £200/actual ha taken out of production and 24% of the baseline basic payments. These estimates are a similar order of magnitude to the current AECS creation and management of species rich grassland option (£285/ha).

Figure 6.36: FBS representative livestock farm, 148 ha, habitat conservation

Source: own estimates; Key: see Annex 1

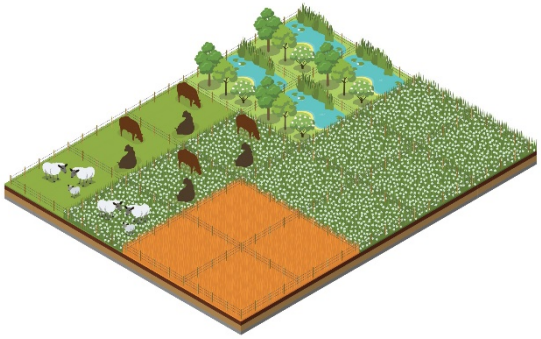


Figure 6.37: Case study livestock farm L, 113 ha, habitat conservation

Source: own estimates; Key: see Annex 1

6.4.8 Nature restoration

The nature restoration option is the most radical of all, with 50% of the farm assumed to be taken out of production and allowed to revert to natural conditions with a mix of trees, shrubs and other vegetation (separate from any commercial forestry). Some groundworks relating to water courses, e.g. blocking drains, may be required to initiate restoration processes. Grassland patches in clearings are maintained with limited browsing by herbivores such as cattle. In the lowland livestock case, permanent grassland areas including rough grazing, are prioritised for restoration, while higher value crops are retained. For the FBS representative farm, stock numbers are reduced from 135 to 92 LU (Figure 6.38), and on Farm L from 135 to 86 LU (Figure 6.39).

Despite the stock reductions, net profit on the FBS representative lowland livestock farm is *increased* by £38/farm ha (£5.5k/farm), as gross margin reductions are outweighed by the assumed 25% (£17k/farm) reduction in fixed costs. For Farm L, net profit is reduced by £80/farm ha (£9k/farm), which is equivalent to £160/actual ha taken out of production and 49% of the baseline basic payments. The 25% fixed cost reduction assumed reduced potential losses by £17.5k/farm.

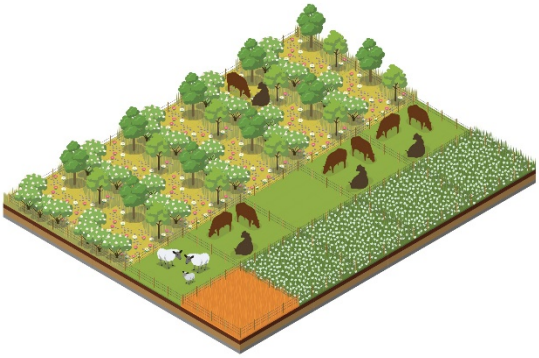


Figure 6.38: FBS representative livestock farm, 148 ha, nature restoration

Source: own estimates; Key: see Annex 1

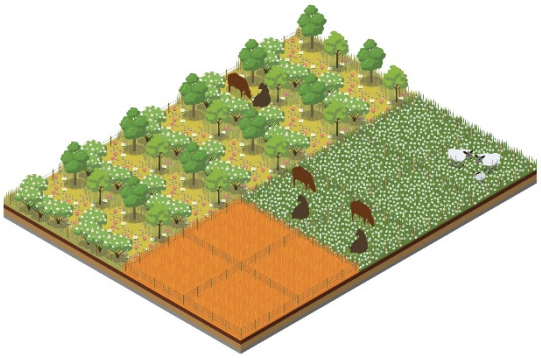


Figure 6.39: Case study livestock farm L, 113 ha, nature restoration

Source: own estimates; Key: see Annex 1

6.5 Hill sheep

For a description of the hill sheep farm type and case study Farm H, see Section 4.5. The structural and financial characteristics of the baseline models are detailed in Table 6.7 for the FBS representative farm and Table 6.8 for the case study farm. These tables also provide the model results for all options. Commercial forestry and native woodlands already present on the farms are not included in the tables and figures presented.

The FBS representative hill sheep farm baseline model is 426 ha, of which 76 ha are permanent grass and 350 ha rough grazing (Figure 6.40). The baseline model projects stocking with 310 ewes and nine beef cows, which is somewhat lower than the current situation in practice. The representative farm generates a net loss before subsidies of nearly £28k (£66/farm ha). Support payments add £54k to that, resulting in a total net profit of £26k. For this farm type, agri-environment payments at £14k/farm are particularly important. The case study hill sheep Farm H baseline model is 2,248 ha, of which 72 ha are permanent grassland and 2,176 ha rough grazing (Figure 6.41). 277 ewes are kept, but no beef cattle. Farm H generates a net loss before subsidies of nearly £11k (£5/ha). Support payments add £38k to that, resulting in a total net profit of £27k.

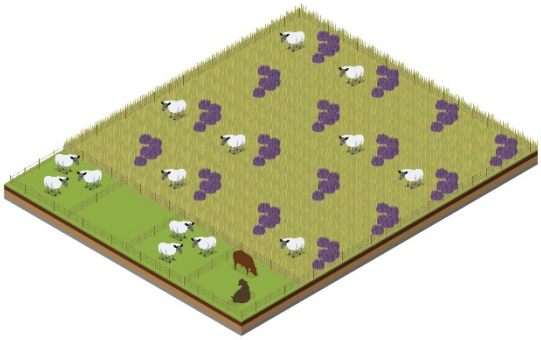


Figure 6.40: FBS representative hill sheep farm, 426 ha, baseline

Source: own estimates; Key: see Annex 1

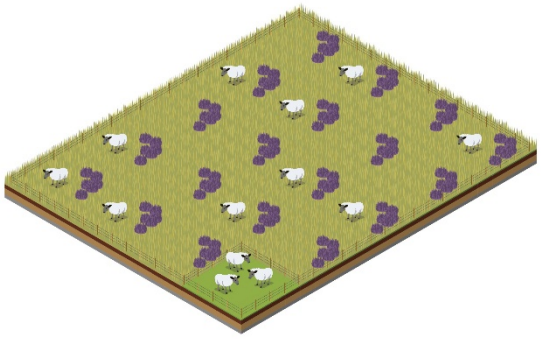


Figure 6.41: Case study hill sheep farm H, 2248 ha, baseline

Source: own estimates; Key: see Annex 1

6.5.1 Reduced agrochemical inputs and increased input use efficiency

Two versions of this option have been analysed, involving 10% and 20% reductions in input use, with livestock numbers maintained as a result of improved efficiency. Fixed costs are assumed to remain constant. For the FBS representative farm, there is virtually no change in net profit. For Farm H, net profit was estimated to increase by £550/farm for each 10% reduction in input use. Given the already low input use on this farm type, this option may not always be relevant.

6.5.2 Environmental set-aside

Two versions of this option have been analysed, involving 5% and 10% of permanent grass area designated primarily for wildlife and ecosystem service provision. These are similar to the current policies for 5% ecological focus areas as part of Greening and, in the 10% case, at least 6m uncropped field margins. For both the FBS representative farm (Figure 6.42) and Farm H (Figure 6.43), the financial impacts estimated were negligible. In practice, this option is unlikely to be relevant for this farm type.

Table 6.7: Model results for hill sheep FBS representative farm

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)												
Permanent grassland	76	76	76	73	70	73	70	76	76	76	76	76
Rough grazing	350	350	350	350	350	350	350	350	333	315	265	137
Agroforestry trees	0	0	0	0	0	0	0	0	18	35	0	0
Uncropped margins	0	0	0	3	6	3	6	0	0	0	85	213
Total area	426	426	426	426	426	426	426	426	426	426	426	426
Livestock (head)												
beef	9	9	9	9	9	9	9	8	9	9	8	6
sheep	310	310	310	310	310	310	310	250	310	310	275	175
Livestock units (LU)	54	54	54	54	54	54	54	44	54	54	48	31
Stocking rate (LU/ha)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.10	0.13	0.14	0.14	0.15
Financial data (£/farm)												
Gross margin	18034	18037	18038	18034	18034	18036	18038	15193	18034	18034	16003	10460
beef	2732	2733	2733	2732	2732	2732	2733	2512	2732	2732	2428	1821
sheep	15302	15304	15305	15302	15302	15304	15305	12681	15302	15302	13574	8638
Fixed costs	46056	46056	46056	46056	46056	46056	46056	46056	46056	46056	46056	34542
Net profit (excl. subsidies)	-28022	-28019	-28018	-28022	-28022	-28020	-28018	-30863	-28022	-28022	-30053	-24082
Basic payment	39842	39842	39842	39842	39842	39842	39842	39842	39842	39842	39842	39842
Agri-env payment	14199	14199	14199	14199	14199	14199	14199	14199	14199	14199	14199	14199
Net profit (incl. subsidies)	26019	26022	26023	26019	26019	26021	26023	23178	26019	26019	23988	29959
Financial data (£/farm ha)												
Gross margin	42	42	42	42	42	42	42	36	42	42	38	25
beef	6	6	6	6	6	6	6	6	6	6	6	4
sheep	36	36	36	36	36	36	36	30	36	36	32	20
Fixed costs	108	108	108	108	108	108	108	108	108	108	108	81
Net profit (excl. subsidies)	-66	-66	-66	-66	-66	-66	-66	-72	-66	-66	-71	-57
Basic payment	94	94	94	94	94	94	94	94	94	94	94	94
Agri-env payment	33	33	33	33	33	33	33	33	33	33	33	33
Net profit (incl. subsidies)	61	61	61	61	61	61	61	54	61	61	56	70
Difference compared with baseline (£/farm)												
Gross margin	0	3	4	0	0	2	4	-2841	0	0	-2031	-7574
beef	0	1	1	0	0	0	1	-220	0	0	-304	-911
sheep	0	2	3	0	0	2	3	-2621	0	0	-1728	-6664
Fixed costs	0	0	0	0	0	0	0	0	0	0	0	-11514
Net profit (excl. subsidies)	0	3	4	0	0	2	4	-2841	0	0	-2031	3940
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	3	4	0	0	2	4	-2841	0	0	-2031	3940
Difference compared with baseline (£/farm ha)												
Gross margin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.7	0.0	0.0	-4.8	-17.8
beef	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	0.0	0.0	-0.7	-2.1
sheep	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.2	0.0	0.0	-4.1	-15.6
Fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-27.0
Net profit (excl. subsidies)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.7	0.0	0.0	-4.8	9.2
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.7	0.0	0.0	-4.8	9.2

Table 6.8: Model results for hill sheep case study Farm H

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)												
Permanent grassland	72.0	72.0	72.0	68.4	64.8	68.4	64.8	72.0	72.0	72.0	72.0	72.0
Rough grazing	2176	2176	2176	2176	2176	2176	2176	2176	2067	1958	1726	1052
Agroforestry trees	0	0	0	0	0	0	0	0	108.8	217.6	0	0
Uncropped margins	0	0	0	3.6	7.2	3.6	7.2	0	0	0	449.6	1124
Total area	2248	2248	2248	2248	2248	2248	2248	2248	2248	2248	2248	2248
Livestock (head)												
beef	0	0	0	0	0	0	0	5	0	0	0	5
sheep	277	277	277	277	277	277	277	240	277	277	250	114
Livestock units (LU)	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.6	38.8	38.8	35	21
Stocking rate (LU/ha)	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.018	0.019	0.019	0.019
Financial data (£/farm)												
Gross margin	7318	7861	8440	7633	7282	7861	8439	7841	7283	7283	6605	4519
beef	0	0	0	0	0	0	0	1500	0	0	0	1500
sheep	7318	13068	8440	7633	7282	7861	8439	6341	7283	7283	6605	3019
Fixed costs	18300	18300	18300	18300	18300	18300	18300	18300	18300	18300	18300	13725
Net profit (excl. subsidies)	-10982	-10439	-9860	-10667	-11018	-10439	-9861	-10459	-11017	-11017	-11695	-9206
Basic payment	17640	17640	17640	17640	17640	17640	17640	17640	17640	17640	17640	17640
Agri-env payment	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
Net profit (incl. subsidies)	26658	27201	27780	26973	26622	27201	27779	27181	26623	26623	25945	28434
Financial data (£/farm ha)												
Gross margin	3.3	3.5	3.8	3.4	3.2	3.5	3.8	3.5	3.2	3.2	2.9	2.0
beef	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.7
sheep	3.3	5.8	3.8	3.4	3.2	3.5	3.8	2.8	3.2	3.2	2.9	1.3
Fixed costs	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	6.1
Net profit (excl. subsidies)	-4.9	-4.6	-4.4	-4.7	-4.9	-4.6	-4.4	-4.7	-4.9	-4.9	-5.2	-4.1
Basic payment	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Agri-env payment	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Net profit (incl. subsidies)	11.9	12.1	12.4	12.0	11.8	12.1	12.4	12.1	11.8	11.8	11.5	12.6
Difference compared with baseline (£/farm)												
Gross margin	0	543	1122	315	-36	543	1121	523	-35	-35	-713	-2799
beef	0	0	0	0	0	0	0	1500	0	0	0	1500
sheep	0	5750	1122	315	-36	543	1121	-977	-35	-35	-713	-4299
Fixed costs	0	0	0	0	0	0	0	0	0	0	0	-4575
Net profit (excl. subsidies)	0	543	1122	315	-36	543	1121	523	-35	-35	-713	1776
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	543	1122	315	-36	543	1121	523	-35	-35	-713	1776
Difference compared with baseline (£/farm ha)												
Gross margin	0.0	0.2	0.5	0.1	0.0	0.2	0.5	0.2	0.0	0.0	-0.3	-1.2
beef	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.7
sheep	0.0	2.6	0.5	0.1	0.0	0.2	0.5	-0.4	0.0	0.0	-0.3	-1.9
Fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.0
Net profit (excl. subsidies)	0.0	0.2	0.5	0.1	0.0	0.2	0.5	0.2	0.0	0.0	-0.3	0.8
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	0.2	0.5	0.1	0.0	0.2	0.5	0.2	0.0	0.0	-0.3	0.8

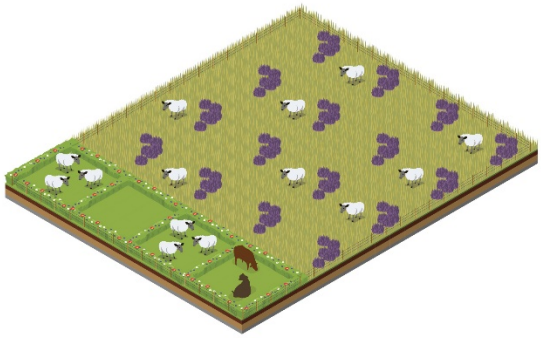


Figure 6.42: FBS representative hill sheep farm, 426 ha, uncropped field margins

Source: own estimates; Key: see Annex 1

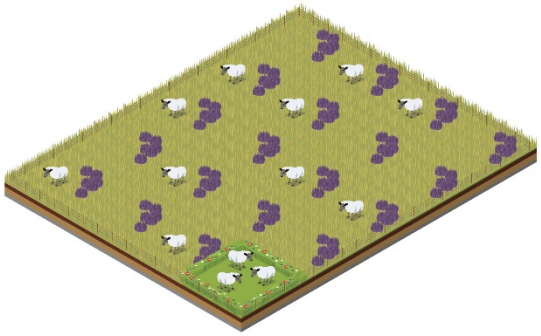


Figure 6.43: Case study hill sheep farm H, 2248 ha, uncropped field margins

Source: own estimates; Key: see Annex 1

6.5.3 Options 1 and 2 combined

The above two options could be combined on the same field, with one focused on the field margins and the other focused on the cropped land. However, as the impacts of both options were negligible, it is not surprising that the combination also had negligible financial impacts on both farms.

6.5.4 Conservation agriculture

This option is not applicable to this farm type.

6.5.5 Organic farming

Organic farming on livestock farms requires the use of white clover and other legumes in improved grassland to replace synthetic nitrogen fertilisers. Slot seeding and other techniques may be used to enhance clover content in permanent swards. Stocking rates per forage ha are estimated to be 20% lower than under non-organic management, in part due to not using nitrogen fertiliser, but also due to reduced reliance on purchased (organic) concentrates. On the FBS representative farm (Figure 6.44), ewe numbers are reduced from 310 to 250. On Farm H (Figure 6.45), ewe numbers fall from 277 to 240.

For these farms, no organic premium prices have been assumed, given the current state of the market. On the FBS representative farm, net profit before subsidies is estimated to fall by £7/farm ha (£3k/farm). For Farm H, net profit is estimated to increase by £500/farm (less than £1/ farm ha). For this farm type, conversion costs are also low, but where feed purchases are needed, the extra cost of organic feed can be a significant issue. The current AECS organic options provide for a higher rate conversion payment (first two years only) of: £140/ha for improved grass and £12.50/ha for rough grazing. For subsequent maintenance, the rates are £55/ha for improved grass and £8.50/ha for rough grazing. These values are not inconsistent with the model estimates.

There may be scope for this option to be combined with other options (e.g. agroforestry, habitat conservation and nature regeneration) but these possible combinations have not been analysed separately.

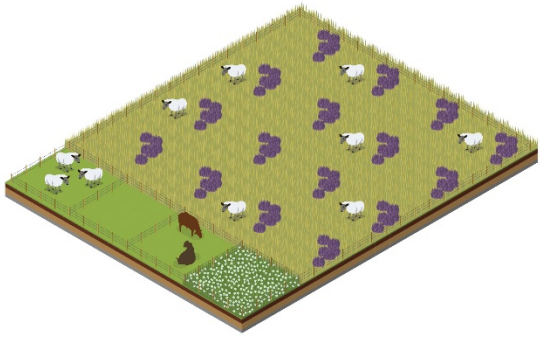


Figure 6.44: FBS representative hill sheep farm, 426 ha, organic farming

Source: own estimates; Key: see Annex 1

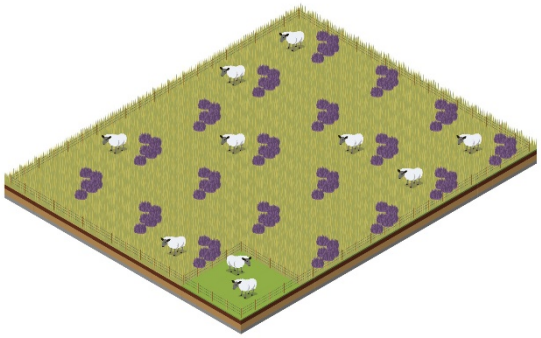


Figure 6.45: Case study hill sheep farm H, 2248 ha, organic farming

Source: own estimates; Key: see Annex 1

6.5.6 Agroforestry

Two agroforestry options have been evaluated involving 5% or 10% of land being occupied by trees. In the hill sheep case, this is primarily based on the introduction of shelter belts on rough grazing land, with associated benefits for animal welfare and management. The two uptake rates analysed reflect different shelter belt frequencies. Hedges are unlikely to be an option for this farm type. There are already some shelterbelts on Farm H, as well as commercial forestry, but these have not been illustrated. For the FBS farm (Figure 6.46) and Farm H (Figure 6.47), a negligible financial impact is estimated. Establishment costs of up to £5k/ha need to be considered. The current AECS capital grant scheme for small scale farm woodlands including shelter belts is relevant in this context, providing £2,400/ha for creation and £400/ha for maintenance.

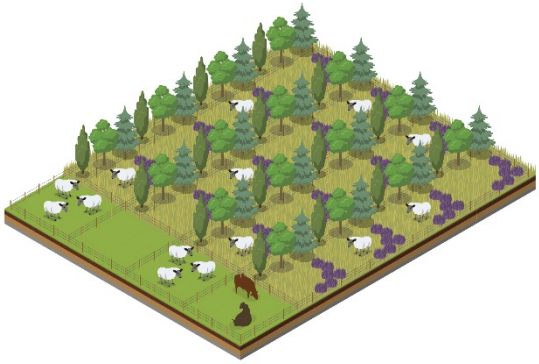


Figure 6.46: FBS representative hill sheep farm, 426 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

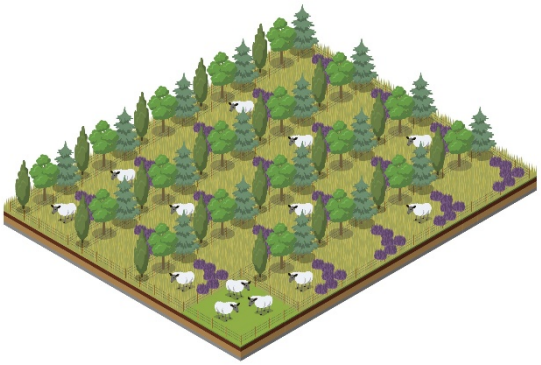


Figure 6.47: Case study hill sheep farm H, 2248 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

6.5.7 Habitat conservation

The habitat conservation option assumes that 20% of the farm is taken out of food production and focused on wildlife and ecosystem services. This may be a combination of protecting existing habitats or creating new ones. The level of AECS income on the hill sheep farms and crofts suggest some moorland habitats already present and actively conserved. For the purpose of this analysis, it is assumed that new habitats are conserved. For the FBS representative farm, this involves 85 ha of rough grazing and a reduction in ewe numbers from 310 to 275 (Figure 6.48). For Farm H, 450 ha of rough grazing are taken out of production and ewe numbers reduced from 277 to 250 (Figure 6.49).

Net profit on the FBS representative hill sheep farm is reduced by £5/farm ha (£2k/farm). This represents about £25/actual ha taken out of production, and 5% of the baseline basic payments. For Farm H, net profit is reduced by less than £1/farm ha (£700/farm), which is equivalent to £1.50/actual ha taken out of production and 4% of the baseline basic payments. Current AECS options, such as moorland management which pays £3-5 per ha, may be relevant in this context.

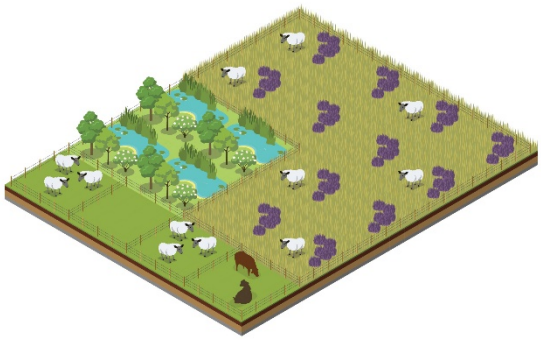


Figure 6.48: FBS representative hill sheep farm, 426 ha, habitat conservation

Source: own estimates; Key: see Annex 1

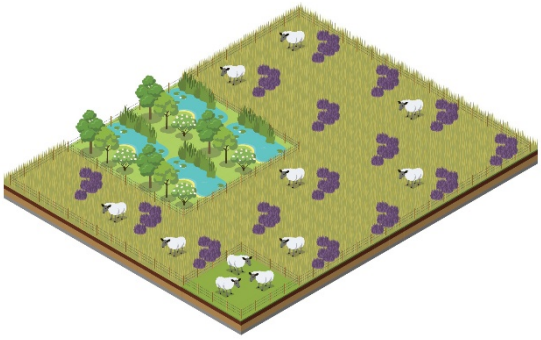


Figure 6.49: Case study hill sheep farm H, 2248 ha, habitat conservation

Source: own estimates; Key: see Annex 1

6.5.8 Nature restoration

The nature restoration option is the most radical of all, with 50% of the farm assumed to be taken out of production and allowed to revert to natural conditions with a mix of trees, shrubs and other vegetation. Some groundworks relating to water courses, e.g. blocking drains, may be required to initiate restoration processes. Grassland patches in clearings are maintained with limited browsing by herbivores such as cattle. In the hill livestock case, rough grazing is prioritised for restoration. For the FBS representative farm, ewe numbers are reduced from 310 to 175 (Figure 6.50), and on Farm H from 277 to 114 (Figure 6.51).

Despite the stock reductions, net profit on the FBS representative hill sheep farm is *increased* by £9/farm ha (£4k/farm), as gross margin reductions are outweighed by the assumed 25% (£11.5k/farm) reduction in fixed costs. For Farm H, net profit is *increased* by £1/farm ha (£2k/farm), with fixed cost reductions contributing £4.5k/farm.

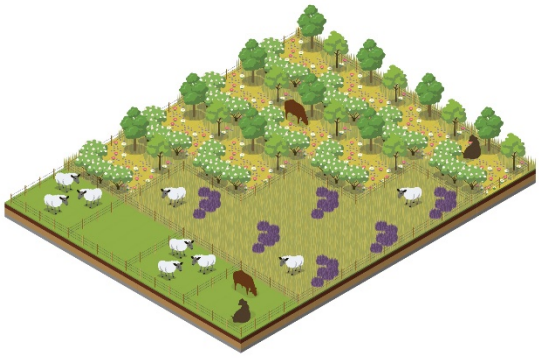


Figure 6.50: FBS representative hill sheep farm, 426 ha, nature restoration

Source: own estimates; Key: see Annex 1

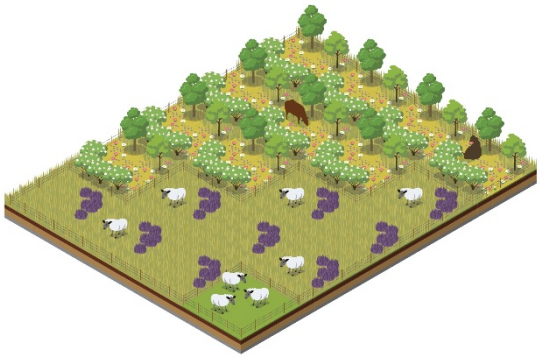


Figure 6.51: Case study hill sheep farm H, 2248 ha, nature restoration

Source: own estimates; Key: see Annex 1

6.6 Crofts

For a description of crofting as a farm type and case study Crofts C1 and C2, see Section 4.6. The structural and financial characteristics of the baseline models are detailed in Table 6.9 for the Uist Croft C1 and Table 6.10 for Skye Croft C2. These tables also provide the model results for all options. Commercial forestry and native woodlands already present on the farms are not included in the tables and figures presented.

The case study Croft C1 baseline model is larger than many, totalling 455 ha, of which 23 ha are arable crops, 151 ha are permanent grass and 282 ha rough grazing (Figure 6.52). The baseline model projects stocking with 166 ewes and 40 beef cattle. The croft generates a net loss before subsidies of around £5k (£11/farm ha). Support payments add £63k to that, resulting in a total net profit of £58k. For Croft C1, agri-environmental payments at £16k/farm are particularly important.

The case study Croft C2 baseline model is 438 ha, with no tillage and only 9 ha of improved grassland. The remaining 429 ha are rough grazing (Figure 6.53). 220 ewes and a few beef cattle are kept. The croft generates a net loss before subsidies of nearly £9k (£20/farm ha). Support payments add £17k to that, resulting in a total net profit of £8k. There is also some native woodland which is not shown in the table and figures.

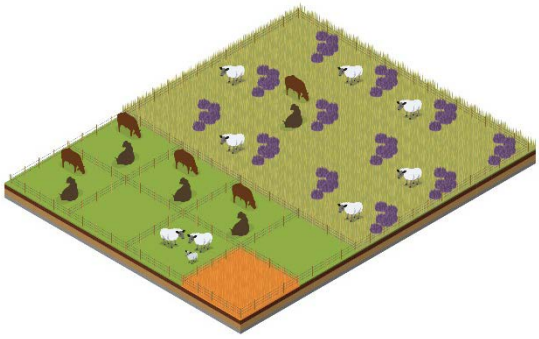


Figure 6.52: Case study croft C1, 455 ha, baseline

Source: own estimates; Key: see Annex 1

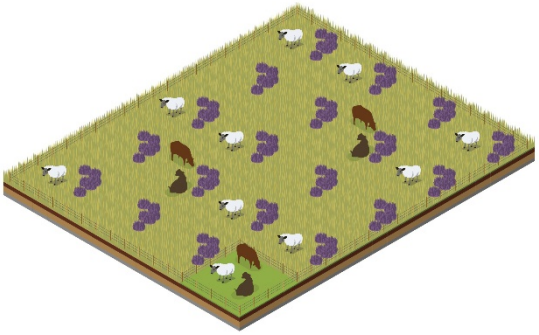


Figure 6.53: Case study croft C2, 438 ha, baseline

Source: own estimates; Key: see Annex 1

6.6.1 Reduced agrochemical inputs and increased input use efficiency

Two versions of this option have been analysed, involving 10% and 20% reductions in input use, with livestock numbers maintained as a result of improved efficiency. Cropped areas and fixed costs are assumed to remain constant. For case study Croft C1, there is a £2.50/farm ha (£1,000/farm) increase in gross margins for each 10% reduction in inputs. For Croft C2, as with the similar hill sheep cases, there is a negligible financial impact. The difference is a reflection of the cropping activities on C1. Given the already low input use on Croft C2, it is questionable whether this option is of relevance for that type of croft.

6.6.2 Environmental set-aside

Two versions of this option have been analysed, involving 5% and 10% of the tillage and permanent grass area designated primarily for wildlife and ecosystem service provision. These are similar to the current policies for 5% ecological focus areas as part of Greening and, in the 10% case, at least 6m uncropped field margins. This option is not applied to rough grazing land. For both Croft C1 (Figure 6.54) and Croft C2 (Figure 6.55), the financial impacts estimated were negligible. In practice, environmental set aside would generally not apply to this farm type. However, for Croft 1 the AECS cropped machair option, costed at £240/ha, may be relevant.

Table 6.9: Model results for crofting case study Croft C1

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)												
Arable land	22.5	22.5	22.5	21.4	20.3	21.4	20.3	22.5	22.5	22.5	22.5	22.5
Permanent grassland	150.6	150.6	150.6	143.1	135.6	143.1	135.6	150.6	143.1	135.6	150.6	150.6
Rough grazing	282.2	282.2	282.2	282.2	282.2	282.2	282.2	282.2	268.1	254.0	191.2	54.5
Agroforestry trees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.6	43.3	0.0	0.0
Uncropped margins	0.0	0.0	0.0	8.7	17.3	8.7	17.3	0.0	0.0	0.0	91.1	227.7
Total area	455.4	455.4	455.4	455.4	455.4	455.4	455.4	455.4	455.4	455.4	455.4	455.4
Livestock (head)												
beef	40	40	40	40	40	40	40	37	40	40	38	28
sheep	166	166	166	166	166	166	166	153	166	166	155	110
Livestock units (LU)	65	65	65	65	65	65	65	58	65	65	60	43
Stocking rate (LU/ha)	0.15	0.15	0.15	0.15	0.16	0.15	0.16	0.135	0.16	0.17	0.17	0.17
Financial data (£/farm)												
Gross margin	22330	23402	24474	22310	22430	23502	24633	19637	22619	22908	20854	14031
beef	17248	17747	18247	17161	17072	17660	18071	15954	17160	17072	16386	12074
sheep	9262	9416	9571	9262	9262	9416	9571	8537	9262	9262	8648	6137
crops	-4180	-3761	-3344	-4113	-3904	-3574	-3009	-4854	-3803	-3426	-4180	-4180
Fixed costs	27446	27446	27446	27446	27446	27446	27446	27446	27446	27446	27446	20585
Net profit (excl. subsidies)	-5116	-4044	-2972	-5136	-5016	-3944	-2813	-7809	-4827	-4538	-6592	-6553
Basic payment	24225	24225	24225	24225	24225	24225	24225	24225	24225	24225	24225	24225
Agri-env payment	15925	15925	15925	15925	15925	15925	15925	15925	15925	15925	15925	15925
Coupled & LFASS paym't	23054	23054	23054	23054	23054	23054	23054	23054	23054	23054	23054	23054
Net profit (incl. subsidies)	58087	59159	60231	58067	58187	59259	60390	55394	58376	58665	56611	56650
Financial data (£/farm ha)												
Gross margin	49.0	51.4	53.7	49.0	49.3	51.6	54.1	43.1	49.7	50.3	45.8	30.8
beef	37.9	39.0	40.1	37.7	37.5	38.8	39.7	35.0	37.7	37.5	36.0	26.5
sheep	20.3	20.7	21.0	20.3	20.3	20.7	21.0	18.7	20.3	20.3	19.0	13.5
crops	-9.2	-8.3	-7.3	-9.0	-8.6	-7.8	-6.6	-10.7	-8.4	-7.5	-9.2	-9.2
Fixed costs	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	45.2
Net profit (excl. subsidies)	-11.2	-8.9	-6.5	-11.3	-11.0	-8.7	-6.2	-17.1	-10.6	-10.0	-14.5	-14.4
Basic payment	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2
Agri-env payment	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Coupled & LFASS paym't	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6
Net profit (incl. subsidies)	127.6	129.9	132.3	127.5	127.8	130.1	132.6	121.6	128.2	128.8	124.3	124.4
Difference compared with baseline (£/farm)												
Gross margin	0	1072	2144	-20	100	1172	2303	-2693	289	578	-1476	-8299
beef	0	499	999	-87	-176	412	823	-1294	-88	-176	-862	-5174
sheep	0	154	309	0	0	154	309	-725	0	0	-614	-3125
crops	0	419	836	67	276	606	1171	-674	377	754	0	0
Fixed costs	0	0	0	0	0	0	0	0	0	0	0	-6862
Net profit (excl. subsidies)	0	1072	2144	-20	100	1172	2303	-2693	289	578	-1476	-1437
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Coupled & LFASS paym't	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	1072	2144	-20	100	1172	2303	-2693	289	578	-1476	-1437
Difference compared with baseline (£/farm ha)												
Gross margin	0.0	2.4	4.7	0.0	0.2	2.6	5.1	-5.9	0.6	1.3	-3.2	-18.2
beef	0.0	1.1	2.2	-0.2	-0.4	0.9	1.8	-2.8	-0.2	-0.4	-1.9	-11.4
sheep	0.0	0.3	0.7	0.0	0.0	0.3	0.7	-1.6	0.0	0.0	-1.3	-6.9
crops	0.0	0.9	1.8	0.1	0.6	1.3	2.6	-1.5	0.8	1.7	0.0	0.0
Fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-15.1
Net profit (excl. subsidies)	0.0	2.4	4.7	0.0	0.2	2.6	5.1	-5.9	0.6	1.3	-3.2	-3.2
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coupled & LFASS paym't	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	2.4	4.7	0.0	0.2	2.6	5.1	-5.9	0.6	1.3	-3.2	-3.2

Table 6.10: Model results for crofting case study Croft C2

Scenarios	2017-18 Baseline	1a: 10% input reduction	1b: 20% input reduction	2a: 5% un-cropped	2b: 10% un-cropped	3a: 1a and 2a combined	3b: 1b and 2b combined	5: Organic farming	6a: 5% land trees for agro-forestry	6b: 10% land trees for agro-forestry	7: 20% habitat	8: 50% nature restoration
Land use data (ha/LU)												
Permanent grassland	8.8	8.8	8.8	8.3	7.9	8.3	7.9	8.8	8.3	7.9	8.8	8.8
Rough grazing	429.3	429.3	429.3	429.3	429.3	429.3	429.3	429.3	407.8	386.4	341.7	210.3
Agroforestry trees	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9	43.8	0.0	0.0
Uncropped margins	0.0	0.0	0.0	0.5	0.9	0.5	0.9	0.0	0.0	0.0	87.6	219.1
Total area	438.1	438.1	438.1	438.1	438.1	438.1	438.1	438.1	438.0	438.1	438.1	438.1
Livestock (head)												
beef	8	8	8	8	8	8	8	8	8	8	8	6
sheep	220	220	220	220	220	220	220	220	220	220	220	180
Livestock units (LU)	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	31.2
Stocking rate (LU/ha)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.11	0.12
Financial data (£/farm)												
Gross margin	3145	3310	3474	3145	3145	3310	3474	3260	3260	3260	3145	2527
beef	675	677	678	675	675	677	678	676	676	676	675	506
sheep	2470	2633	2796	2470	2470	2633	2796	2584	2584	2584	2470	2021
Fixed costs	11875	11875	11875	11875	11875	11875	11875	11875	11875	11875	11875	8906
Net profit (excl. subsidies)	-8730	-8565	-8401	-8730	-8730	-8565	-8401	-8615	-8615	-8615	-8730	-6379
Basic payment	4365	4365	4365	4365	4365	4365	4365	4365	4365	4365	4365	4365
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Coupled & LFASS paym't	12280	12280	12280	12280	12280	12280	12280	12280	12280	12280	12280	12280
Net profit (incl. subsidies)	7915	8080	8244	7915	7915	8080	8244	8030	8030	8030	7915	10266
Financial data (£/farm ha)												
Gross margin	7.2	7.6	7.9	7.2	7.2	7.6	7.9	7.4	7.4	7.4	7.2	5.8
beef	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.2
sheep	5.6	6.0	6.4	5.6	5.6	6.0	6.4	5.9	5.9	5.9	5.6	4.6
Fixed costs	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	27.1	20.3
Net profit (excl. subsidies)	-19.9	-19.6	-19.2	-19.9	-19.9	-19.6	-19.2	-19.7	-19.7	-19.7	-19.9	-14.6
Basic payment	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coupled & LFASS paym't	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0
Net profit (incl. subsidies)	18.1	18.4	18.8	18.1	18.1	18.4	18.8	18.3	18.3	18.3	18.1	23.4
Difference compared with baseline (£/farm)												
Gross margin	0	165	329	0	0	165	329	115	115	115	0	-618
beef	0	2	3	0	0	2	3	1	1	1	0	-169
sheep	0	163	326	0	0	163	326	114	114	114	0	-449
Fixed costs	0	0	0	0	0	0	0	0	0	0	0	-2969
Net profit (excl. subsidies)	0	165	329	0	0	165	329	115	115	115	0	2351
Basic payment	0	0	0	0	0	0	0	0	0	0	0	0
Agri-env payment	0	0	0	0	0	0	0	0	0	0	0	0
Coupled & LFASS paym't	0	0	0	0	0	0	0	0	0	0	0	0
Net profit (incl. subsidies)	0	165	329	0	0	165	329	115	115	115	0	2351
Difference compared with baseline (£/farm ha)												
Gross margin	0.0	0.4	0.8	0.0	0.0	0.4	0.8	0.3	0.3	0.3	0.0	-1.4
beef	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4
sheep	0.0	0.4	0.7	0.0	0.0	0.4	0.7	0.3	0.3	0.3	0.0	-1.0
Fixed costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.8
Net profit (excl. subsidies)	0.0	0.4	0.8	0.0	0.0	0.4	0.8	0.3	0.3	0.3	0.0	5.4
Basic payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agri-env payment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coupled & LFASS paym't	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net profit (incl. subsidies)	0.0	0.4	0.8	0.0	0.0	0.4	0.8	0.3	0.3	0.3	0.0	5.4

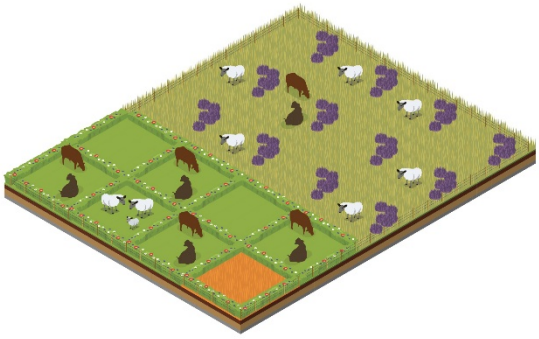


Figure 6.54: Case study croft C1, 455 ha, uncropped field margin

Source: own estimates; Key: see Annex 1

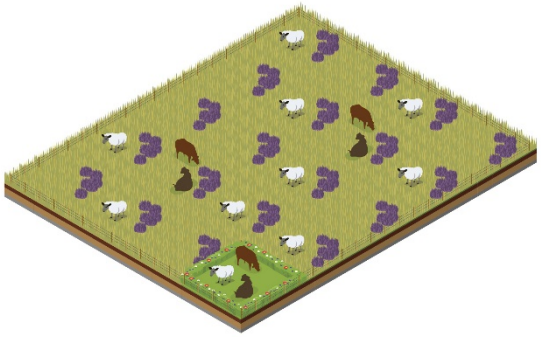


Figure 6.55: Case study croft C2, 438 ha, uncropped field margin

Source: own estimates; Key: see Annex 1

6.6.3 Options 1 and 2 combined

The two options could be combined on the same field, with one focused on the field margins and the other focused on the cropped land. On Croft C1, 10% reduction in input and 5% environmental set aside combined resulted in a £1,200/farm increase in profit, while 20% reduction in input and 10% environmental set aside resulted in £2,300/farm increase in net profit. The impacts of both options were negligible on Croft C2, and it is not surprising that the combination also had negligible financial impacts.

6.6.4 Conservation agriculture

This option is not applicable to this farm type.

6.6.5 Organic farming

Organic farming on livestock farms requires the use of white clover and other legumes in grassland to replace synthetic nitrogen fertilisers. Reseeding to achieve this can increase the proportion of rotational grassland relative to permanent, although slot seeding and other techniques may be used to enhance clover content in permanent swards. Stocking rates per forage ha are reduced, in part due to not using nitrogen fertiliser, but also due to reduced reliance on purchased (organic) concentrates. On case study Croft C1 (Figure 6.56), the arable area is maintained, and stock numbers are reduced from 65 to 58 LU. On Croft C2 (Figure 6.57), no change in land use or stocking is foreseen due to the already very low stocking rates.

For these farms, no organic premium prices for livestock have been assumed, given the current state of the market and peripherality of the crofts. On Croft C1, net profit before subsidies is estimated to fall by £3k/farm (£6/farm ha). For Croft C2, net profit is estimated to increase by a very modest £100/farm. For these crofts, conversion costs are also low, but where feed purchases are needed, the extra cost of organic feed can be a significant issue. The current AECS organic options provide for a higher rate conversion payment (first two years only) of: arable £280/ha, improved grass £140/ha and rough grazing £12.50/ha. For subsequent maintenance the rates are: arable £65/ha, improved grass £55/ha and rough grazing £8.50/ha. Support at these rates could be attractive in this context.

There may be scope for this option to be combined with other options (e.g. agroforestry, habitat conservation and nature regeneration), but these possible combinations have not been analysed separately.

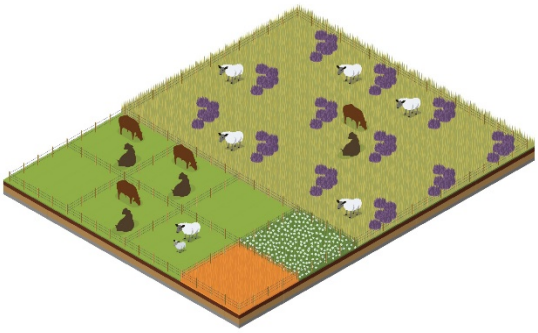


Figure 6.56: Case study croft C1, 455 ha, organic farming

Source: own estimates; Key: see Annex 1

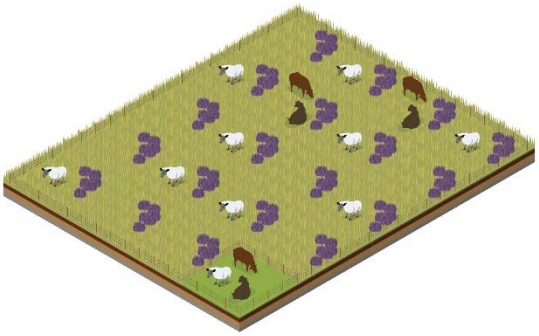


Figure 6.57: Case study croft C2, 438 ha, organic farming

Source: own estimates; Key: see Annex 1

6.6.6 Agroforestry

Two agroforestry options have been evaluated involving 5% or 10% of land being occupied by trees. In the crofting case, this includes both shelter belts on rough grazing land and wood pasture on the improved grassland. Existing shelterbelts and commercial forestry are not illustrated. The wood pasture assumes planting 200 trees/ha with the intention to thin to 100 trees/ha allowing both better trees to be retained for timber and for some revenue from thinning. It would include mixed native conifer and broadleaf appropriate for the land classification (e.g. scots pine and birch), with a higher proportion of deciduous trees than conifers to give light levels sufficient for grass growth. Hedges are unlikely to be an option for this farm type.

The two uptake rates analysed reflect different shelter belt frequencies and levels of uptake of wood pasture. Although agroforestry would not be an ideal land use in the Uists due to limited suitable land and climate for growing trees, the financial impact was nonetheless estimated to illustrate the implication of introducing agroforestry on a croft. Agroforestry is a practice considered more relevant to other crofting areas such as Skye. For Croft C1 (Figure 6.58), and Croft C2 (Figure 6.59), as in the hill farming case, a negligible financial impact is estimated. Establishment costs of up to £5k/ha need to be considered. The current AECS capital grant scheme for small scale farm woodlands including shelter belts is relevant in this context, providing £2,400/ha for creation and £400/ha for maintenance.

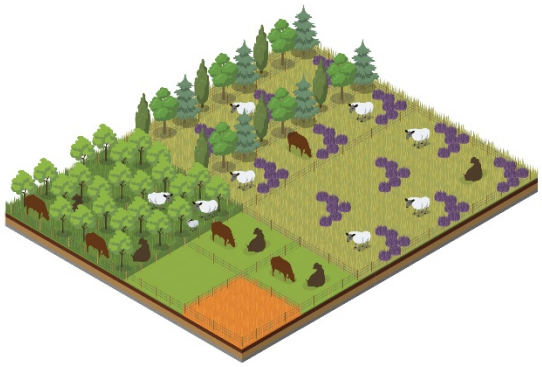


Figure 6.58: Case study croft C1, 455 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

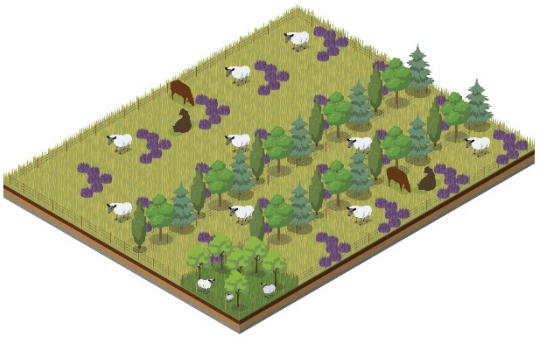


Figure 6.59: Case study croft C2, 438 ha, agroforestry (5% tree cover)

Source: own estimates; Key: see Annex 1

6.6.7 Habitat conservation

The habitat conservation option assumes that 20% of the farm is taken out of food production and focused on wildlife and ecosystem services. This may be a combination of protecting existing habitats or creating new ones. The level of AECS income on the hill sheep and croft farms suggest some moorland habitats are already present and actively conserved. For the purpose of this analysis, it is assumed that new habitats are conserved. For Croft C1, this involves removing 91 ha of rough grazing from production and a reduction in stock numbers from 65 to 60 LU (Figure 6.60). For Croft 2, 88 ha of rough grazing are taken out of production, but with no overall change in stock numbers (Figure 6.61). Net profit on Croft C1 is reduced by £3/farm ha (£1.5k/farm). This represents about £16/actual ha taken out of production, and 3% of the baseline basic and coupled payments. For Croft C2, no net financial impact is estimated. Current AECS options, such as moorland management which pays £3-5/ha, may be relevant in this context.

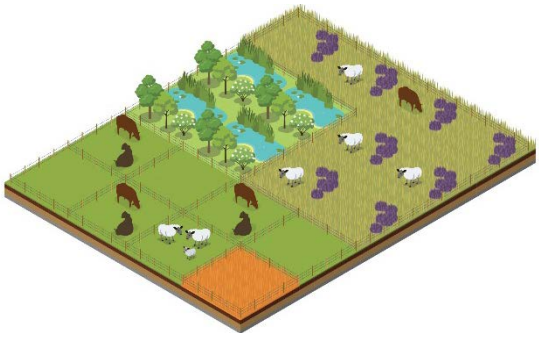


Figure 6.60: Case study croft C1, 455 ha, habitat conservation

Source: own estimates; Key: see Annex 1

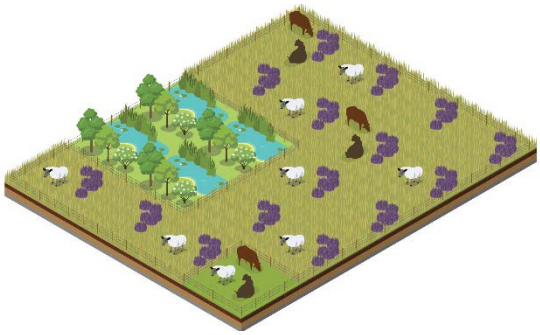


Figure 6.61: Case study croft C2, 438 ha, habitat conservation

Source: own estimates; Key: see Annex 1

6.6.8 Nature restoration

The nature restoration option is the most radical of all, with 50% of the farm assumed to be taken out of production and allowed to revert to natural conditions with a mix of trees, shrubs and other vegetation. Some groundworks relating to water courses, e.g. blocking drains, may be required to initiate restoration processes. Grassland patches in clearings are maintained with limited browsing by herbivores such as cattle. In the crofting case, rough grazing is prioritised for restoration. For Croft C1, 228 ha of rough grazing are taken out of production and stock numbers are reduced from 65 to 43 LU (Figure 6.62). For Croft C2, 219 ha rough grazing is restored, with ewe numbers reduced from 220 to 180 (Figure 6.63). Net profit on Croft C1 is reduced by £3/farm ha (£1.5k/farm), with gross margin reductions offset by the assumed 25% (£7k/farm) reduction in fixed costs. For Croft C2, net profit is increased by £5/farm ha (£2k/farm), with fixed cost reductions contributing £3k/farm.

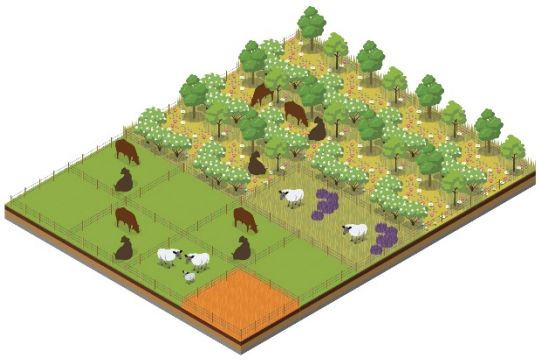


Figure 6.62: Case study croft C1, 455 ha, nature restoration

Source: own estimates; Key: see Annex 1

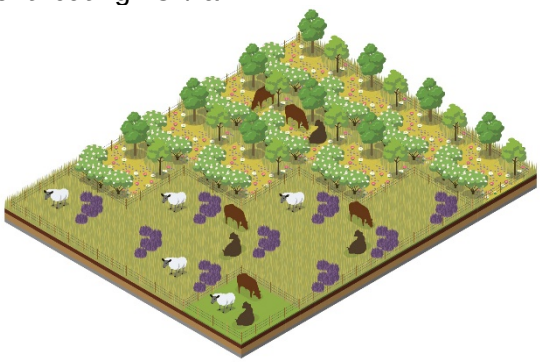


Figure 6.63: Case study croft C2, 438 ha, nature restoration

Source: own estimates; Key: see Annex 1

7. CASE STUDY FARMER REACTIONS TO OPTIONS

7.1 Farm A (arable)

The farmer has considered agri-environment schemes in the past, but the AECS scoring system did not score them highly enough based on what they were able to implement on the farm, which is focused strongly on malting barley production. Even the three crop rules for Greening were seen as a challenge. He feels it is unfair that he has environmental costs such as NVZ that some others do not have. He thinks a lot of environmental/public benefit work is just hassle – the constraints on what you can do all add up. There must be sufficient reward – it needs to be a partnership and practical. He operates a business and it needs to make money.

As a tenant, the farmer was concerned about some public benefit delivery being outside the specified agricultural focus, as well as the long-term implications of both hedge-planting (which he did previously, but now has to maintain them under cross-compliance), and agroforestry, with the feeling that the 'land would be lost forever'. This is an issue that has affected other tenant farmers, with landlords potentially requiring that the trees are removed when the tenancy comes to an end. However, there were some perceptions that agro-forestry and forestry were the same in this context. He would still be interested in an option focused on hedges, but only if payments were available.

He was sceptical about the scope for further cost reduction, particularly at the 20% level, but noted that machinery efficiency was continuously improving. Market volatility affecting both inputs and outputs post-Brexit was a concern. One-off capital items, including to enhance environmental delivery, could be relevant.

Uncropped field margins around the arable fields would be an option (and preferable to setting aside a single block of land), but he would want to see some flexibility in management, for example allowing grazing or topping once the crop had been harvested. On large fields, areas in the middle of the field might be more appropriate.

The conservation agriculture option was of potential interest, if it could generate additional returns as projected. He would need further information on costings and how it would work in practice, in particular on whether field beans were viable in the NE of Scotland. He was also concerned about potential problems establishing cover crops in wet autumns, and whether the cover crops could be grazed with sheep (note from authors: this would be possible). He was also concerned that zero tillage would not work on his type of land.

Habitat conservation and nature restoration options might also be conceivable if there was funding. As a business management decision, they would have to make economic sense.

Some combination of elements of the above options would be consistent with addressing the low score for Agri-environmental Management in the sustainability assessment.

He was less keen on the organic scenario, in part because of concerns about the impact of on his carbon footprint of using a lot more fuel and gas (note from authors: this would not necessarily be the case). He would need more information on weed control options, and performance comparisons. He was also concerned about the impact on the market if adopted widely with insufficient demand.

He was less keen on the idea of public access on the farm, but more so about possible community engagement activities and opportunities to improve staff skills and the CSR credentials if financial rewards are available.

7.2 Farm D (dairy)

The farm actually has 180 cows, but the baseline model projected only 135 on the basis of future price projections and other constraints. This herd size is considered not to be representative of the direction of travel, with herd sizes in Scotland increasing. It was felt that it will not be long before herds smaller than 150 milking cows are unviable for conventional production.

The input reduction options were considered generally desirable, but the farmer considered that loss of production would be inevitable given the level of intensity they were operating at. They were previously participants in the Climate Change Focus Farm project and are very focused on progressive, sustainable and efficient farming.

The uncropped field margin options would be achievable, depending on habitat management criteria, and would help address some low scoring elements of the sustainability assessment.

The farmer felt that payments for organic farming are encouraging, but the practicalities of organic milk production and keeping it separate from non-organic on a large scale will be challenging, and a cost milk companies will expect producers to cover in some capacity.

For the agroforestry options the farmer was not clear how this related to existing woodland and was concerned that it would be in direct conflict with traditional best practice for grassland management. Hedges as proposed in the dairy farm case would, however, be something the farmer would be willing to consider.

Alternative land uses including habitat conservation or nature restoration are possible provided producers receive a realistic income for farming, regardless of subsidy. The Scottish Government has to show a commitment to continuing support for livestock agriculture, even in the face of climate change and other environmental issues. The farmer wanted it noted that he believes strongly that SRDP funding has historically been more accessible for upland farms and rural businesses and that many lowland farms need greater access to support mechanisms. He is a keen environmentalist and would have liked to have been involved in an environmental scheme in some capacity but has found that scoring mechanisms disproportionately benefit crofts and upland estates, something he believes has hampered uptake from the dairy industry.

7.3 Farm L (lowland livestock)

The farmer considered that the uncropped field margin options would probably be the easiest to undertake, but believed that they would impact on the profitability of the farm business, as more forage would need to be bought in from other farms. He did not understand how these options could be more profitable. However, the models projected that stocking rates would be increased on the remaining land, so that livestock numbers could be maintained, with slightly poorer financial performance.

The input reduction and improved efficiency options seemed most appealing, as it related to improving technical performance. Although improvements could be made, he was concerned that some fixed costs (fuel and machinery) would increase as additional forage would be bought in by sourcing from local farms, or that animal health would suffer, with resulting increase in losses/deaths. An increased focus on rotational/paddock grazing could help mitigate this slightly to accommodate the higher stocking rates. Opportunities to reduce fertiliser inputs by, for example, increased reliance on legumes in pastures, were not mentioned.

The combination of these options might also be possible, with losses in production due to uncropped margins just counteracted by the reduction in costs. He was concerned that the more ambitious combination (10% uncropped and 20% input reduction) would not be achievable in practice, as stocking rates were increased while at the same time reducing costs.

As far as the organic option was concerned, he liked the idea of premiums, but the practicalities of organic standards would reduce its attractiveness, due to current sourcing of forage off farm. He believed that restrictions on forage purchases would probably see a bigger reduction in stocking rates and therefore profits. This might be resolved if forage could be sourced from another organic farm.

He was not keen on the agroforestry options. It was felt that the scattered individual trees agroforestry option would cause issues with future cultivation of the fields, as all the fields were in rotation, and random scattered trees would cause operational problems (e.g. use of boom sprayer, FYM muck and fertiliser spreaders, tree roots blocking drains). However, this option was envisaged for the permanent grassland area, which accounts for about 50% of the total grassland on the farm. The farm currently has 20 ha of woodland and shelterbelts, providing good areas of shelter, which are valued currently as some stock are outwintered. He was not keen to expand the forestry area further, as this might lead to more problems, with regard to flies, such as fly strike in sheep and mastitis problems in cattle.

As far as the financial assessments were concerned, the farmer was sceptical about the results, as the assumptions seemed quite vague and the baseline was not representative of his average net profit performance over the last few years. It should be noted that the baseline model results do not necessarily reflect actual results on the case study farm, due to the use of future price projections over a 12-year period. In this case however, stock numbers modelled were similar to the actual levels recorded on the farm.

There were no detailed comments recorded on the 20% habitat conservation and 50% nature restoration options. The farm is currently participating in an AECS, which was designed to work with what they were currently doing, to help minimise disruption to the existing farming system. As these options potentially involve more significant changes, they were of less interest.

There is already a public access track through the farm; they did not want to encourage any more access, due to range of issues they have experienced in past (e.g. fly tipping, sheep worrying and petty theft around the farm).

7.4 Farm H (hill sheep)

Farm H has very little impact from the different options, as confirmed in Section 6.5 with respect to input use reduction and uncropped margins. This is largely down to the extensive nature of the farm. The farm is already very reliant on the both LFASS and AECS payments to maintain viability. Both farmers are aware of this. Unlike dairy and arable enterprises, which have sizeable non-subsidy income, the hill sheep enterprise only has the production of store lambs and little room to increase production by any large amount or change the type of enterprise. The baseline farm model, however, already projects a 50% reduction in current sheep numbers, from 600 to less than 300 ewes as a result of future price projections.

Agroforestry is of potential interest depending on how it would be implemented and its relationship to the 307 ha forestry already on the farm. About 80% of this is commercial forestry and 20% diverse multi-species, multi-layer shelterbelts. The latter are currently non-productive, but have potential for timber and biomass, having been planted as commercial forestry. The farmers are certainly open to forestry and do not think new plantings of this type would be difficult to integrate into the farm.

The organic option would also not be that difficult considering they are very low input currently. There would be an increase in feed costs, which is the major issue. The potential to combine with agroforestry as suggested in Section 6.5 might be worth exploring further.

With regards to nature restoration and habitat conservation options, the farmers were sceptical about how it would be implemented on their farm. They viewed these options as something more for low-ground and arable farmers with more productive farms. They considered that the majority of the farm is already essentially a “wild” environment, which they are managing with minimal production from it. They are currently implementing various relevant AECS options including moorland management (deer and livestock), away wintering of sheep, predator control and, on the in-bye land, species-rich grassland creation and management, and wild bird seed. The moorland management option is crucial to making it economical to put the sheep out on the hill and to control deer numbers. The moorland management option also made it possible to get a number of capital options like dyke restoration and bracken control which improved the condition of the moorland. A version of the moorland management option would be consistent with the habitat conservation option evaluated in this study.

They did not consider the nature restoration option involving complete removal of sheep and deer and allowing natural regeneration of the landscape in detail.

Both farmers took a fairly negative view of public access options. They are far away from urban areas so it is not something they encounter very often.

The farmers did raise their hope that any new options would be simpler and less bureaucratic than the current AECS, which they find very cumbersome. The management required is off-putting, and they are very concerned about being penalised for any small infractions. However, considering the low profitability of the farm without AECS, they view it as necessary.

7.5 Croft C1 (Uist)

The croft has been in agri-environment schemes for some time, implementing several options: cropped machair, use of seaweed on cropped machair, species-rich grassland management, corncrake mown grassland, corncrake grazing management, management of cover for corncrakes, wader-grazed grassland and habitat mosaic management. They would be keen to remain in if the payments remained attractive, as it is a crucial part of the unit’s viability. The crofter would favour similar schemes to those available currently, but payment rates need to remain attractive, the schemes should be simple to apply for, and some of the rules should be less restrictive.

The input reduction option was considered potentially useful, although input use was already quite low. Some improvements could potentially be made with respect to fertilisers and bought in feed. The crofter was less convinced about uncropped margins, given that the natural environment in the area depends on active management. Whole system approaches such as organic farming were not really considered relevant and he was unsure about the idea of agroforestry (note agroforestry is not an ideal land use in the Uists due to limited suitable land and climate for growing trees, and sensitivities of some key habitats such as machair and peatlands). For habitat conservation, existing schemes work reasonably well, but there are some options that could be tweaked. He was less convinced about the large-scale nature restoration option – active crofting and agriculture is very important for their designated sites. Public access to the croft was already extensive due to the beach access and open nature of croft.

7.6 Croft C2 (Skye)

This business has never participated in environmental schemes. It was not felt that they were appropriate for the scale of the business – any schemes implemented should have low transaction costs for small units such as crofts, and for complex applications like common grazing. They need to help reward low intensity systems including hill cattle and sheep and support the biodiversity already present (see below), rather than having to create new habitats. The LFASS parachute support system proposed in 2017 but deferred, which involved 80% of previous rates being paid, would have a negative impact on this business, which would struggle and likely need to reduce activity.

The crofter felt that the reduced input option was not so relevant, as the croft is already an example of High Nature Value (HNV) farming with low inputs. However, the crofter did see great value in new technology such as tags that can locate a cow on large hill grazings, or virtual fencing.

The crofter was not opposed to setting some land aside for environmental purposes, but there are issues with practicality. The croft is small (ca. 7ha) and narrow, with many of the fields only 45m wide. It was felt that options targeted at the whole unit may be better. A system that benefits all the land worked in a High Nature Value system is important. Since the inbye is small, any hectare-based payments become meaningless and result in non-participation.

The crofter felt that a whole croft approach that included their 7 ha of inbye and 140 ha apportionment would be useful. There are areas of native woodland in a mosaic with the moorland in the apportionment. If there was a payment that rewarded this, but did not need the areas to be fenced off or the stock excluded, this would be welcomed. In general, there is a need for simpler systems to help native woodlands on common grazings and moorland management.

The croft has some very derelict stone walls – the huge investment in restoration/ management would need to be funded from a landscape fund as they have no agricultural purpose now. The crofter would take part if support provided full costs for stone dyke management.

Organic farming was not considered to be possible because of the cost of organic feeds, and the distance from organic markets, as well as the lack of a developed market for organic store animals.

The crofter was aware of the wood pasture scenario proposed for the crofts. He felt he already had a good proportion of trees including hazel/birch woodland and some oaks. He has no desire to expand these areas although would be interested in payments to manage them. The apportionment land has native woodland, which is neither under any schemes nor fenced separately. It provides shelter but can be difficult to gather stock in. There may be options to survey and perhaps manage this area better if the schemes could recognise this type of habitat. They have looked at forestry schemes for the common grazings, but only small areas are possible due to depth of peat. The cost of fencing these small areas means current payments are not attractive. However, there would be interest if this could be addressed.

Although this crofter has not participated in any agri-environment schemes previously, he would welcome the habitat conservation option as long as the schemes were designed to be more suitable for small crofts and common grazings. This would include a simpler application process, more support for the work needed to do a common grazings application and a move away from options that want to fence off individual areas. The payment rates also need to be worth the risk of extra inspections to be attractive.

The crofter felt the focus on large scale nature restoration may be inappropriate. They were already delivering many public goods with a managed-habitat approach, many of which were not yet being rewarded, including:

- sensitive management of peat areas providing carbon storage
- sensitive management of limestone pavements
- moorland including small amount of juniper
- habitat for hen harriers, golden and sea eagles
- native woodland on the croft, apportionment and common grazings
- semi-natural grasslands which include globe flowers and orchids
- clean water from a low input system
- good air quality, albeit more from the location than the crofting system
- good soil structure from long term pastures, and
- the right to roam in Scotland

They did not think they were delivering public goods relating to flood prevention, conservation of renewable resources (except peat) and climate change mitigation/ adaptation, although the agroforestry options might address the latter.

Concerning public access, the crofter felt that, while Scotland has a right to roam, paths might help the management of visitors better. Communities should be included more in path planning and restoration. There is an issue of dog worrying livestock and irresponsible access but more communication with communities could assist with this.

7.7 Concluding note

In most cases, the farmers' responses were framed more in the context of current policy and agri-environment schemes. The possibility of a radical shift from basic payments to a 'public money for public goods' approach post-Brexit does not appear to have significantly impacted on their perceptions of the different options.

Some options were well covered in the responses, but other including agroforestry, habitat conservation and nature restoration were not. It is not clear that farmers had access to the more detailed descriptions of agroforestry on each farm type, which might explain the frequent confusion with forestry. As the financial evaluations of habitat conservation and nature restoration had not been completed at the time of the farmer interviews, these options appear to have received less attention.

8. DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

In this chapter, we summarise the results from the modelling and case study farms, and draw conclusions relating to each of the options to deliver public goods as outlined in Chapter 3. We discuss the feasibility, potential risks, and advantages of the various proposals, as well as potential payment rates. We finish with recommendations for the next steps that might be taken in terms of needs for further research and the issues to be addressed in developing future schemes.

We do this conscious of the limitations of the modelling and case study approach used in this study, as detailed in Section 6.1 above. Some significant simplifying assumptions were needed for modelling purposes, and the case study farms, while illustrative of the farm type, are not necessarily representative or typical farms. However, the results do at least highlight some key issues and raise questions that will need to be addressed in future planning, including more precise modelling of both the environmental public goods delivered and financial impacts of any schemes to be implemented in practice.

8.1 Payment contexts, approaches and possible models

The aim of this study was to evaluate the implications on different farm types of a shift in policy support from basic and coupled payments for agricultural production, to using the payments to fund the delivery of public goods, including the reduction of negative externalities beyond levels required by regulation.

Given the current importance of CAP support payments of all kinds as a proportion of farm income on Scottish farms (see Sections 8.1.1 and 8.1.2), the potential loss of these income sources under a future agricultural policy is a serious issue. The ability to retain this income in exchange for the delivery of public goods should be of significant interest to farmers, even if not yet fully reflected in the wider debate and in the responses received from the limited number of case study farms.

While the results shown in Chapter 6 include the baseline (2017/18) support payments being maintained, this is presented for contextual purposes only. In practice, there is likely to be a redistribution of support payments between farms, as some engage more than others with public benefit delivery. This study does not attempt to predict or assess the extent of any possible redistribution, adopting more of a “what if” approach to the assessment of the different options.

8.1.1 Basic and coupled payments (BCPs)

Basic and coupled payments are an important part of Scottish farm incomes, with values ranging from £19k to £47k per farm, or £160-300/ha on lowland farms (Table 8.1). For upland farms and crofts, similar values per farm may be applicable, but values per ha are reduced by the extent of rough grazing on the farm. As a share of farm net profit, BPS income is lowest on dairy farms (21-27%) and highest on other livestock farms, often exceeding the farm net profit by a significant margin. The differences in the value of BCPs as a proportion of net profit, between the individual case study farm and FBS representative farm models for the same farm type, illustrate the high degree of variability between farms. Unsurprisingly given coverage elsewhere, the loss of these support payments would have a significant negative financial impact on almost all farms, putting the survival of many in doubt.

Table 8.1: Baseline (2017/18) CAP basic and coupled payment receipts on FBS and case study farms by farm type, actual values and as share of farm net profit

		Arable		Dairy		Lowland livestock		Hill sheep		Crofting	
Income source	**Units**	**FBS**	**Farm A**	**FBS**	**Farm D**	**FBS**	**Farm L**	**FBS**	**Farm H**	**Croft C1**	**Croft C2**
Basic/coupled paymt	£/farm	41062	26043	34644	35583	44960	18525	39842	17640	47279	16645
Basic/coupled paymt	£/farm ha	211	159	235	224	304	163	94	8	104	38
Net profit (baseline)	£/farm	95183	28509	128304	169899	23780	31483	26019	26658	58087	7915
BCP share of profit	%	43%	91%	27%	21%	189%	59%	153%	66%	81%	210%

8.1.2 Agri-environment payments

In general terms, average agri-environment payment receipts were much lower on the most intensive arable and dairy farm types, with values of under £2,500 per farm or £17/farm ha, which represent less than 7% of net profit (Table 8.2). This is despite the actual rate per ha for options for these farm types being relatively high, indicating low overall rates of uptake. For the other livestock farms, including both lowland and hill farm types, and the crofting case studies, AECS payments ranged from £6-20k per farm, or up to £64/ha, with payments on Farm H accounting for most of the farm net profit. The higher average receipts despite lower value per ha for individual AECS options on these farm types indicate a generally higher level of engagement with AECS,

Table 8.2: Baseline (2017/18) SRDP agri-environment payments on FBS and case study farms by farm type, actual values and as share of farm net profit

		Arable		Dairy		Lowland livestock		Hill sheep		Crofting	
Income source	**Units**	**FBS**	**Farm A**	**FBS**	**Farm D**	**FBS**	**Farm L**	**FBS**	**Farm H**	**Croft C1**	**Croft C2**
AECS payment	£/farm	339	747	2527	0	9419	6120	14199	20000	15925	0
AECS payment	£/farm ha	2	5	17	0	64	54	33	9	35	0
AECS share of profit	%	0%	3%	2%	0%	40%	19%	55%	75%	27%	0%

It may be that the other livestock farms were more likely to engage with AECS options because of the need to increase and diversify income streams, or that the options available to them reflected the environmental and public benefit potential of the land resource they were managing. For the more intensive arable and dairy farms, commercial priorities and the relatively high value financial potential of the farms may have resulted in less willingness to engage with AECS options, even if/though higher rates of payment had been calculated to compensate for the greater income foregone on these farm types.

8.1.3 Setting payment rates

The aim here is not to set final payment rates for different options, but to outline the main considerations that might apply when this is done.

Under the CAP, the main approach to setting agri-environment payments has been the WTO-compatible compensation for income foregone and additional costs incurred, including transaction costs. If estimated effectively, then most farmers would not make losses from engaging in agri-environment options, but there would also be no (or very limited) incentive or reward built in for undertaking these activities. In practice, actual income foregone and costs incurred may vary significantly on individual farms, so that some farmers will not be fully compensated, and others will receive an unintended bonus. The variation may be influenced by differences in methodologies used in different regions, including cost and income factors

included or excluded[53]. This approach has also been criticised because the payments do not necessarily reflect the value of the public goods delivered, and those farming most intensively, and thereby generating most negative externalities, face the largest income reductions and can receive the highest payments, in contradiction to the polluter pays principle.

The public money for public goods approach would suggest that a different approach to calculating payments is needed[54]. The environmental benefits generated by farmers should be quantified and rewarded appropriately. There would then be a good incentive for farmers to incorporate production of these benefits in their business models in response to the remuneration on offer, just as they would with the production of food and other private goods, leading to more benefits being supplied where demand is high enough. However, many of the environmental benefits are difficult to quantify and relate to individual holdings, and the administrative costs of doing this exactly may outweigh the value of changing the payment system (generally, inputs are easier to monitor and audit than the outputs, which is one of the reasons why the income foregone approach has persisted). Despite this, if appropriate indicators can be defined for outputs such as nitrogen balances, GHG emissions and key species numbers, there will be some activities that could be rewarded on a payment for result (benefit) basis. Such payments would transfer the financial risk of non-delivery from the government to the land manager. They have mainly been tested in the UK for biodiversity objectives. Further information on possible results-based payment schemes is set out in Annex 2.

However, even if the environmental benefits produced can be identified and quantified on a cost-effective basis, the challenge of what price or value to put on these remains. The benefits are public goods because there is no market mechanism determining their value. There is also no intrinsic value that is independent of political considerations or economic conditions determining government willingness and ability to pay. Compromise options may be relevant, such as:

- calculating the mitigation costs saved if less nitrates and pesticides need to be removed from water supplies;
- (reverse) auction-style tendering options, where farmers bid for a share of an available pot of resources depending on what they think they need to deliver a specific output (with the result that individual farmers might receive different payments for the same outputs);
- tradeable carbon quotas in a market established by regulators; and
- points-based systems, where so much is paid per point, with the number of points for an activity or outcome reflecting its value to society (or at least policy-makers), and the farmer determining how many points s/he is willing to sign up to deliver – those less willing to engage would receive fewer points and lower payments.

There might also be options for public-private partnerships or business payments for ecosystem services in this context. The water clean-up issue is one example, and the practice of 'offsetting' carbon or biodiversity impacts of activities or developments through tree planting or other actions is becoming more widespread. In Germany, some organic farming initiatives are also being supported in an offsetting context. Further consideration of this type of approach can be found in Section 3.2.4.

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[53] Vlahos, G. & Tsakalou, E. 2007*. Summary review of payment calculations for agri-environmental measures.* WP2 Report from AGRIGRID project. https://macaulay.webarchive.hutton.ac.uk/agrigrid/documents/WP2_AEM_report.pdf

[54] Reed, M.S., Moxey, A., Prager, K., Hanley, N., Skates, J., Bonn, A., Evans, C.D., Glenk, K. & Thomson, K. 2014. Improving the link between payments and the provision of ecosystem services in agri-environment schemes. *Ecosystem Services* 9:44-53.

In practice, for public-funded schemes, there may well be good arguments for continuing with an income foregone basis for a proportion of the benefit options to be implemented, provided that they better recognise the real variations in the economic and environmental situation of a larger proportion of farmers. In reality, the costs to the farmer of delivering the required outputs are important, and a cost-plus model is used elsewhere in the public sector to fund public services. Notional public benefit values might fail to be cost covering and achieve limited results, although there is also a need to ensure costs supported, for example per bird protected, are not excessive.

Current practice could be extended to include an incentive element that might be varied to achieve desired uptake rates, with higher payments offered if insufficient producers are participating. The total budget for this might be determined by the current budget for the basic payment scheme, plus or minus a percentage to reflect the political priority for securing environmental public goods.

As part of this, more attention could be paid to the issue of opportunity costs and the impacts of a farmer ceasing to undertake an environmentally beneficial activity. This is already the basis for organic maintenance payments calculated with reference to the possible reversion to conventional management, although distorted by the inclusion of premium prices which reflect the market activities of farmers more than the generation of environmental benefits from organic land management. It would also be the basis for rewarding maintenance of existing high-quality habitats, for example on uneconomic hill farms using HNV systems where the rational business alternative is at present land abandonment or afforestation.

In the following sections, we attempt to identify which of the issues outlined here are most relevant when it comes to determining the payment model.

8.2 Environmental maintenance and improvement scheme

This scheme, with a number of different components as set out in Section 3.2.1, was evaluated in simplified terms of 10% and 20% input use reduction while maintaining output, and 5% and 10% uncropped areas (environmental set-aside), as well as combinations of the two. The results are summarised in Table 8.3, Table 8.4 and Table 8.5.

The input use reduction options (Table 8.3) have greatest financial impact, as might be expected, on input-intensive arable and dairy systems, as well as on Farm L which has a relatively high proportion of arable cropping. Other livestock systems, with more limited or no arable cropping and less intensive grassland management, show very limited financial impacts, at least on a per ha basis. Given the assumptions used in the modelling, the financial as well as the environmental impact is positive, providing a win-win scenario. However, the models did not take account of the advisory and other costs to the farmer that might be involved in implementing the measures, for example in preparing environmental plans, sustainability assessments, nutrient and energy budgets, and pesticide reduction plans. These costs could amount to £1,000-2,000 per farm, which would offset, and in some cases eliminate, the financial benefits indicated. For hill farms and crofts, this option is unlikely to be beneficial or necessary.

Table 8.3: Difference in net profit by farm type resulting from 10% and 20% input use reductions compared with baseline

		Arable		Dairy		Lowland livestock		Hill sheep		Crofting	
PB Option	**Units**	**FBS**	**Farm A**	**FBS**	**Farm D**	**FBS**	**Farm L**	**FBS**	**Farm H**	**Croft C1**	**Croft C2**
10% input reduction	£/farm	3293	4386	1583	776	294	2269	3	543	1072	165
10% input reduction	£/farm ha	17	27	11	5	2	20	0	0	2	0
20% input reduction	£/farm	7036	8771	3179	1552	585	4572	4	1122	2144	329
20% input reduction	£/farm ha	36	54	22	10	4	40	0	0	5	1

Notwithstanding the private benefits calculated, reducing input use would deliver public goods in terms of GHG emission reductions, reduced water and air pollution, and some biodiversity gains. There is, therefore, still a case for some remuneration to recognise this and act as an incentive for producers to engage with the planning and changes needed to achieve real reductions in input use. The payments could be linked to actual reductions in input use achieved. It is, of course, also conceivable that stricter polluter pays requirements are enforced by new regulations, in which case the reductions in negative externalities would cease to be public goods in the sense used in this study (see Chapter 2).

In contrast, for most farm types, the reductions in cropped areas (environmental set-aside) had more significant negative impacts on farm profitability (Table 8.4). For livestock farms, the modelling accommodated the likely response of grassland farmers to the reduced productive areas – maintaining livestock numbers and increasing stocking rates on the remaining land – so that the financial impacts were relatively low. This was not the case for the arable farms and, to a more limited extent, the lowland livestock farms with some arable cropping. Here a pro rata decrease in crop gross margins was assumed, amounting to about £700/uncropped ha for the FBS representative farm, and over £1,000/uncropped ha for Farm A. Averaged out over the whole farm area, typical reductions of £35-50/ha for each 5% of agricultural area uncropped were estimated. This is equivalent to ca. 25% of current BPS payments for these farms, more in the case of Farm A. In practice, it is also possible that for arable crops, the uncropped conservation headlands and other areas set aside would also be less productive, reducing the potential financial impact.

Table 8.4: Difference in net profit by farm type resulting from 5% and 10% uncropped arable and grassland areas compared with baseline

		Arable		Dairy		Lowland livestock		Hill sheep		Crofting	
PB Option	**Units**	**FBS**	**Farm A**	**FBS**	**Farm D**	**FBS**	**Farm L**	**FBS**	**Farm H**	**Croft C1**	**Croft C2**
5% uncropped land	£/farm	-6887	-10471	-33	-257	-67	-395	0	315	-20	0
5% uncropped land	£/farm ha	-35	-64	0	-2	0	-3	0	0	0	0
5% uncropped land	£/uncrop ha	-709	-1280	-4	-32	-9	-69	0	3	-1	0
10% uncropped land	£/farm	-13772	-16443	-67	-514	-35	-738	0	-36	100	0
10% uncropped land	£/farm ha	-71	-101	0	-3	0	-7	0	0	0	0
10% uncropped land	£/uncrop ha	-709	-1005	-5	-32	-2	-65	0	0	2	0

Uncropped field margins and input reduction on the cropped area can be combined on the same fields (also possible on grassland farms if the field margins are fenced off), which is foreseen as part of this scheme. While a range of combinations is conceivable, we evaluated two ends of the spectrum (Table 8.5). For most farm types, the area reduction losses did not outweigh the estimated benefits from input reduction. For arable farms, the impact was still negative due to the financial impacts of uncropped field margins, but reduced compared with the uncropped area option on its own.

Table 8.5: Difference in net profit by farm type resulting from combinations of input reduction and uncropped arable and grassland areas compared with baseline

		Arable		Dairy		Lowland livestock		Hill sheep		Crofting	
PB Option	**Units**	**FBS**	**Farm A**	**FBS**	**Farm D**	**FBS**	**Farm L**	**FBS**	**Farm H**	**Croft C1**	**Croft C2**
5% uncrop 10% red	£/farm	-3754	-7805	2345	519	505	1851	2	543	1172	165
5% uncrop 10% red	£/farm ha	-19	-48	16	3	3	16	0	0	3	0
10% uncrp 20% red	£/farm	-7830	-8549	3850	1038	530	3588	4	1121	2303	329
10% uncrp 20% red	£/farm ha	-40	-52	26	7	4	32	0	0	5	1

For this scheme as a whole (combining all elements as in Section 3.2.1), we conclude that there is a case for considering two or three levels of support covering a) arable land including rotational grassland b) improved permanent grassland and possibly c) unimproved, semi-natural and rough grazing. If no new regulatory or fiscal constraints on input use are introduced, different payments for a) and b) would recognise the differences in typical input use intensity (nitrogen, pesticides and energy for cultivations) and the resulting public goods that could be derived from their reduction, as well as the value of production lost from uncropped areas. As suggested above, advisory costs to the farmer, for environmental and other plans, should also be factored in and payment rates could be varied to reflect the extent of uncropped areas and input reductions achieved. For unimproved land, it may be that some of the habitat conservation or nature restoration options discussed below may be more appropriate.

For the input reduction elements of the scheme, there may be verification and control issues to be addressed. These could be related to the definition of suitable indicators (e.g. for nutrient balances and GHG emissions) as discussed above. Alternatively, if input reductions are promoted primarily through supporting environmental advice, planning and tools for farmers to use, then the take up of the advice could form a basis for verification and control.

8.3 Multi-functional, agro-ecological farming systems scheme

The options evaluated under this scheme – conservation agriculture, organic farming and agro-forestry – are described in more detail in Section 3.2.2. This scheme could also include HNV farming systems, but they have not been separately evaluated in this study. As indicated in Section 3.2.2, it is assumed that these options might be implemented as alternatives to the environmental maintenance scheme, although some elements of the latter could be carried over. Based on the research evidence currently available[55], a broader range and higher level of public benefit delivery may be expected from the implementation of these options than from the environmental maintenance and improvement scheme, while still retaining a primary focus on land use for agricultural production.

Conservation agriculture is characterised by zero tillage, extended rotations and the use of cover crops, and is applicable in an arable farming context. In the modelling exercise, we have assumed that grain legumes (field beans) have been used to diversify cropping and extend the rotation. The combined effect of the changes modelled generated an improvement in financial performance of £7-10k/farm, or about £40-60/ha (Table 8.6). The main public goods are for soil health, including organic matter retention and earthworm activity. Input use is not necessarily reduced. If integrated pest management (IPM) is also adopted, then pesticide use can be reduced, but further steps would need to be taken to reduce nitrogen use. There may, therefore, be a case for linking this option more closely with the environmental maintenance scheme, but with a higher level of remuneration to recognise the additional benefits generated, while recognising that the improved profitability might also help offset some of the costs associated with uncropped land.

[55] *Op cit.* (17)

Table 8.6: Difference in net profit by farm type resulting from conservation agriculture and organic farming options compared with baseline

		Arable		Dairy		Lowland livestock		Hill sheep		Crofting	
PB Option	**Units**	**FBS**	**Farm A**	**FBS**	**Farm D**	**FBS**	**Farm L**	**FBS**	**Farm H**	**Croft C1**	**Croft C2**
Conservation agric.	£/farm	6970	9624								
Conservation agric.	£/farm ha	36	59								
Organic farming	£/farm	41067	18622	-22303	-12250	-5441	-5321	-2841	523	-2693	115
Organic farming	£/farm ha	211	114	-151	-77	-37	-47	-7	0	-6	0

Organic farming is applicable across all farm types. In the modelling exercise, premium prices for crops and milk were included, but no or very limited premiums were assumed for beef and sheep, reflecting market conditions in recent years. The support payments currently available for organic conversion and maintenance have been excluded to ensure a comparable basis for assessment with the other options. The modelling results (Table 8.6) indicate that arable farms have the potential to improve financial performance, despite lower yields, thanks to input cost savings and the premium prices available. However, the premium prices assumed for milk were not sufficient to compensate for higher organic feed costs and reduced stocking rates and milk yields per cow and hectare. For the other farm types, reduced stock numbers, more limited opportunities for input cost savings, and lower premium prices also resulted in net profit reductions in most cases, but at lower levels than in the dairy case. These findings (apart from the arable examples) are consistent with the current basis for AECS organic maintenance payments. The projected income reductions represent ca. 60% of BPS payments for the dairy FBS farm and 10% for the other livestock types.

The model results do not reflect the costs of conversion or transition to organic farming. These are both a result of the system changes taking place, for example establishing legumes in grassland and diversifying enterprises, and a consequence of the regulatory restrictions on selling products as organic during the conversion period. As the value of premium prices can be £500/ha or higher (e.g. 10000 L milk/ha at 5p/L premium, or 4t grain/ha at £125/t premium), the conversion costs, even if time limited, can be quite significant.

There is an argument that premium prices should be excluded from, or at least be reduced in, the payment calculation, because they represent a return on marketing activities undertaken by the farmer, rather than the environmental benefits generated as a result of organic land management. Without such marketing activities, the products would have to be sold as non-organic with no premium. The costs of market development have not been included in the modelling assumptions. The inclusion of organic premium prices in income foregone calculations has also led to situations where non-organic farmers receive significantly higher support payments for the same activities, such as limitations on nitrogen use, because they do not receive premium prices. This differential in favour of non-organic farmers has the potential to undermine organic farmers' engagement with delivering public goods.

For agroforestry, different approaches were modelled on the different farm types, reflecting typical practice (Table 8.7). 5% and 10% levels of cover by trees were assumed, reflecting either adoption on a part- or whole-farm basis, or at different intensities on the land in question. For the arable case, alley cropping with apples was used, which has significant cash income potential that was reflected in the positive results. For the other farm types, both positive and negative results were estimated, reflecting a) more limited opportunities for income generation than in the arable case; b) cost savings on the reduced grassland area; and c) the potential to increase stocking rates on the remaining land to avoid having to reduce stock numbers and output.

There are also significant establishment costs to be considered with agroforestry which are not reflected in the modelling results. These relate to the costs of ground preparation, trees, planting and fencing, as well as to the lack of production in the early years, and vary according

to the type of agroforestry adopted. The establishment costs have been illustrated in the relevant sections of Chapter 6, ranging from £500 to £2,500 per ha.

Table 8.7: Difference in net profit by farm type resulting from 5% and 10% agroforestry cover compared with baseline

		Arable		Dairy		Lowland livestock		Hill sheep		Crofting	
PB Option	**Units**	**FBS**	**Farm A**	**FBS**	**Farm D**	**FBS**	**Farm L**	**FBS**	**Farm H**	**Croft C1**	**Croft C2**
5% agroforestry cover	£/farm	29913	12862	1733	-184	924	-179	0	-35	289	115
5% agroforestry cover	£/farm ha	154	79	12	-1	6	-2	0	0	1	0
5% agroforestry cover	£/AF ha	3081	1572	235	-23	125	-31	0	0	13	5
10% agroforestry cover	£/farm	61710	33222	964	-368	189	124	0	-35	578	115
10% agroforestry cover	£/farm ha	318	203	7	-2	1	1	0	0	1	0
10% agroforestry cover	£/AF ha	3176	2031	65	-23	13	11	0	0	13	3

A: alley crop & fruit; D: hedges with trees; L: single trees in perm. grass; H: shelterbelts in rough grazing; C: as H + wood pasture on improved land

In general terms the options in this category will need careful assessment with respect to system definition and validation (e.g. the legal regulation of organic farming standards illustrates this and may be beneficial). The establishment/transition costs will need to be addressed specifically and separately to any longer-term remuneration for the generation of public goods. The remuneration of public goods (including any defined agreement lengths) will need to reflect that farmers engage with such systems on a voluntary basis and can revert to conventional management relatively easily. They will also need to reflect the relative levels of public goods delivered, to avoid situations where market interactions (such as in the organic case) lead to some farmers being paid more for the same or less public benefit delivery.

8.4 Environmental enhancement, habitat conservation and nature restoration scheme

The underlying principles of the environmental enhancement, habitat conservation and nature restoration options can be found in Section 3.2.3. The focus is on the delivery of biodiversity-related public goods with respect to species, habitats and ecosystems, with a primary focus on land use for biodiversity rather than agriculture. As such these options go further than the uncropped land options in Section 8.2 and the multi-functional farming systems in Section 8.3. As mentioned in section 6, the projected impacts of both habitat conservation and nature restoration options were assessed based on pro rata adjustments to the baseline model results.

The financial implications of habitat conservation have been calculated on the basis of 20% of current agricultural land being converted to primarily non-agricultural use, or at least very low intensity use, consistent with habitat management prescriptions, with no initial habitat conservation assumed in the baseline models (Table 8.8). For arable farmers, the income reductions estimated represent ca. 30% of BPS payments. For dairy farmers, the impact would be higher at ca. 70% of BPS payments. For the other farm types the impacts are much lower. In practice, many farmers will already have areas of habitat, which may or may not be managed under AECS options. However, it was not possible to generalise either the type or extent of existing habitats as part of the modelling process. An indicator of the importance of existing habitats and current conservation activities may be the AECS income summarised in Table 8.2. This suggests very little activity on the arable and dairy farms, and modest activity on the other farm types with Farm H and Croft C1 actively engaged. Moorland rough grazing habitats appear to be important in this context. The case study farmer feedback also suggests the arable and dairy farmers would be reluctant to engage at this level, preferring the more farming-focused options discussed above.

Table 8.8: Difference in net profit by farm type resulting from 20% habitat conservation and 50% nature conservation options compared with baseline

		Arable		Dairy		Lowland livestock		Hill sheep		Crofting	
PB Option	**Units**	**FBS**	**Farm A**	**FBS**	**Farm D**	**FBS**	**Farm L**	**FBS**	**Farm H**	**Croft C1**	**Croft C2**
20% habitat conserv.	£/farm	-11921	-11750	-23795	-22576	-2621	-4515	-2031	-713	-1476	0
20% habitat conserv.	£/farm ha	-61	-72	-161	-142	-18	-40	-5	0	-3	0
20% habitat conserv.	£/habitat ha	-307	-359	-806	-711	-88	-199	-24	-2	-16	0
50% nature restore	£/farm	-14168	-15364	-59565	-101988	5534	-9035	3940	1776	-1437	2351
50% nature restore	£/farm ha	-73	-94	-404	-642	37	-80	9	1	-3	5
50% nature restore	£/nature ha	-146	-188	-807	-1284	75	-159	18	2	-6	11

For the large-scale nature restoration option, the results in Table 8.8 indicate that it is unlikely to be an option for dairy farmers, where the income reductions would be more than double current BPS payments, but it might be for arable and lowland livestock farmers if payment rates close to current BPS payments were available. For the hill farming and crofting examples, the results suggest a possible financial improvement in some cases. This should be interpreted with caution, as a major factor in this is the assumption of a 25% reduction in fixed costs. This has been used for illustrative purposes, and would need firmer grounding were a scheme of this type to be developed. If fixed costs remained unchanged, then all the farm types would show net profit reductions for this option.

Peatland management/restoration as discussed in Section 3.2.3.2 was not separately evaluated, but is very relevant in this context. There may be some conflicts with respect to environmental objectives with some of these options. Nature restoration on moorland, for example, could lead in many cases to natural regeneration of scrub and trees once sheep and deer are excluded, which may not be compatible with avoiding tree establishment on peatland, or conservation of key bird species that depend on open semi-natural habitats. However, nature restoration can be envisaged as a mosaic of habitats, which may involve rewetting moorland and the maintenance of some open semi-natural habitats, alongside native woodland expansion.

Given that the baseline models already project stock number reductions as a result of market conditions and future price projections, it is conceivable that the habitat conservation and nature restoration options could be possible on some farms without further stock reductions.

Establishment costs for these options are not necessarily high, but may well include fencing to exclude deer and livestock, and some groundworks, e.g. for water management.

8.5 Overall assessment

The starting point for this study was that current basic and coupled support would be reallocated to pay for public goods. In practice, the resulting level of support would depend on the farmer's choice and uptake of options, as well as the amounts of public goods which the various options might deliver.

For example, a typical BPS/coupled payment of ca. £200/ha lowland or ca. £100/ha hill land due to lower payments on rough grazing) could be applied using notional values as follows:

- 25% for environmental maintenance (10% input reduction and 5% uncropped area);
- 50% for conservation agriculture;
- 75% for organic farming;
- 100% for agroforestry options (5% tree cover);
- 125% for habitat conservation; and
- 150% for nature restoration options

The actual proportions would need to be determined by a combination of the expected environmental benefits and consideration of the income reductions that might result from

taking up the options. For example, nature restoration might yield higher public goods than habitat conservation, but with lower ongoing management costs. However, the opportunity costs of not continuing agricultural production on the land would be higher and would remain longer term.

Illustrations of possible basic and coupled payment (BCP) reallocation results on this basis are shown in Table 8.9. For each farm type, the first column shows the proportion of the farm on which an option is applied and, lower down, the equivalent % of current BCPs. The totals for the individual options may add to more than 100% where options are combinable. The second column shows the value in £/farm ha of the BPS allocation to the option based on the example allocation percentages set out above. In the lower half, the first row shows the full (100%) value of the baseline BCPs (from Table 8.1), while the Public benefit options total row shows the combined value of the BCPs retained under the assumptions applied in each scenario. The subsequent rows show the resulting difference in support payments, net profit excluding support payments, and the overall difference in income combining the two. The net profit differences are combined pro rata from the data in Tables 8.5 to 8.8 above. AECS payments for current agri-environment activities (Table 8.2) are not included – it is assumed these are continued and the payments maintained for activities already being undertaken.

Table 8.9: Illustrative examples for different scenarios of BPS reallocations by farm type

			Arable (FBS)		***Dairy (FBS)***		***Lowl. Livest. (FBS)***		***Hill sheep (FBS)***		***Crofting (Croft C1)***	
Public benefit options	***% BCSP***	***Units***	***% farm***	***Value***	***% farm***	***Value***	***% farm***	***Value***	***% farm***	***Value***	***% farm***	***Value***
Environ. maintenance	25%	£/farm ha	80%	42	0%	0	80%	61	0%	0	40%	10
Conserv. agriculture	50%	£/farm ha	70%	74	0%	0	0%	0	0%	0	0%	0
Organic farming	75%	£/farm ha	0%	0	100%	176	0%	0	0%	0	0%	0
Agroforestry (5%)	100%	£/farm ha	0%	0	50%	117	25%	76	20%	19	50%	52
Habitat conservation	125%	£/farm ha	20%	53	0%	0	20%	76	0%	0	20%	26
Nature restoration	150%	£/farm ha	0%	0	0%	0	0%	0	50%	70	0%	0
Total all options		£/farm ha	170%	169	150%	293	125%	213	70%	89	110%	88
Impacts on support and net profit		***Units***	***% BCSP***	***Value***	***% BCSP***	***Value***	***% BCSP***	***Value***	***% BCSP***	***Value***	***% BCSP***	***Value***
Baseline basic/coupled payment		£/farm	100%	41062	100%	34644	100%	44960	100%	39842	100%	47279
Public benefit options total		£/farm	80%	32850	125%	43305	70%	31472	95%	37850	85%	40187
PB-BCSP difference		£/farm	-20%	-8212	25%	8661	-30%	-13488	-5%	-1992	-15%	-7092
Net profit ex support difference		£/farm	-24%	-10045	-62%	-21437	-4%	-1986	10%	3940	-2%	-863
Overall difference (OD)		£/farm	-44%	-18257	-37%	-12776	-34%	-15474	5%	1947	-17%	-7955
Baseline basic/coupled payment		£/farm ha	100%	211	100%	235	100%	304	100%	94	100%	104
Public benefit options total		£/farm ha	80%	169	125%	293	70%	213	95%	89	85%	88
Overall difference (OD)		£/farm ha	-44%	-94	-37%	-87	-34%	-105	5%	5	-17%	-17
OD as % of baseline net profit incl. support				-19%		-10%		-65%		7%		-14%

To calculate values/actual ha of each option implemented, divide 100% by the % farm allocated and multiply result by value/farm ha

BCSP: Basic and coupled support payments

These figures need to be treated with caution due to their hypothetical, illustrative nature, but as an example they would mean that:

- An arable farm with 80% of the land in environmental maintenance, 70% of the land in conservation agriculture and 20% in habitat conservation options would qualify for 80% of the current (baseline) BCPs, or £169/ha. Overall, the farm would have £94/farm ha (£18,257/farm) less net profit and BCP income, equivalent to 44% of current BCPs and 19% of current net profit including support. This is primarily a consequence of taking 25% of land out of production for the environmental maintenance and habitat conservation options. Other options such as agroforestry (including hedge planting as well as alley cropping) could be implemented to increase the income.
- A dairy farm focused on organic farming on all the land and hedgerow agroforestry on half the land would qualify for about 125% of the current payment, or £293/ha. Overall, the farm would have £87/farm ha (£12,776/farm) less net profit and BCP income, equivalent to 37% of current BCPs and 10% of current net profit including support.
- A hill farm with nature restoration on 50% of the land, and shelterbelt agroforestry on 20%, with no options on the remainder (which is likely to be carrying existing AECS commitments), would qualify for 95% of the current payments or £89/ha. Overall, the

farm would have £5/farm ha (£1,947/farm) more net profit and BCP income, equivalent to 5% of current BCPs and 7% of current net profit including support.

Even if (almost) all BPS is retained to cover the selected options, there may still be some net income reduction, as illustrated by the Crofting scenario.

Establishment/transition costs are not included in these scenarios. Some of the establishment costs identified earlier could be covered by environmental investment support (capital grants), or a supplementary transition scheme as currently in the organic case.

From the interviews with the case study farmers, there seemed to be more a sense of things continuing as they are, including a limited willingness to take up more ambitious agri-environment options, because of competing commercial priorities. However, the impact of the loss of BPS on business profitability, as discussed above, and a limited potential to retain BPS if only entry-level activities were undertaken, might lead to reconsideration on the part of some farmers, or a significant redistribution of support towards those willing to do more.

Some farms would appear to be more profitable with a smaller number of better managed livestock and fewer inputs, possibly combined with some land converted to non-agricultural uses. It might be worth encouraging this and perhaps considering transition schemes to give confidence to change, rather than pay large sums for what might be profitable anyway.

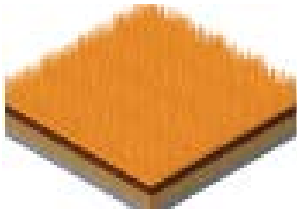
There is also a clear indication from the responses received that lack of familiarity with some of the more ambitious options, such as agroforestry and nature restoration, but also conservation agriculture, would need to be addressed. This might be because the combinations of activities appear too complex, but simpler, entry-level solutions might not deliver the desired outputs. There is a very clear need for well-informed training, advisory and information support as part of the process, which may also involve training for the advisers, trainers and front-line staff involved.

8.6 Recommendations

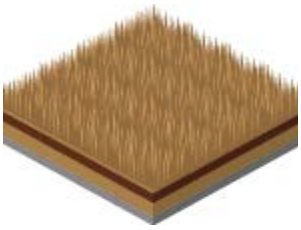
This study represents a preliminary assessment of future options for post-Brexit agri-environmental policy in Scotland. If any of these options are to be taken forward, then the following next steps are recommended, not in any specific order of priority:

1. More clearly define the scope and content of specific options, including distinguishing the establishment/transition phases from longer-term maintenance.
2. Pilot options on individual farms to ensure potential unintended consequences can be avoided, complexities clarified, and information support requirements identified.
3. Assess more precisely the financial implications of the different options, including any interlinking with the phasing out of basic and coupled payments by 2024.
4. Investigate how the public goods already being delivered by more nature friendly (HNV) systems can be better captured in potential options and sustainability assessment tools (see 6. below).
5. Identify what role capital grants might play in the establishment phase of different options.
6. Further investigate, assess and, if necessary, develop the tools and information resources that might be needed to underpin the options (including nutrient and soil organic matter balances, sustainability assessments etc.).
7. Ensure full training and advisory support is available, both for land managers and for front-line staff.
8. Establish the evidence base for the environmental public goods to be expected from the different options. This is likely to form the basis of at least the allocation of resources between different options, if not the actual payments to farmers. A full mapping of the interactions between various public goods and agricultural practices and management systems may be desirable.
9. Explore opportunities for more result-based rather than management/prescription-based options that allow farmers to be more engaged and innovative in how they deliver the scheme requirements.
10. Where the income foregone approach to setting payments continues to be used, ensure that calculations represent the situation on a wide spectrum of farms, and that opportunity costs, including the possibility of reversion to intensive agriculture or abandonment/afforestation in the hills and uplands, are fully reflected.
11. Consider whether there is a need to raise the regulatory floor in some contexts, for example requiring regular testing of soil nutrient levels in catchments.
12. Identify relevant verification and control procedures, both with respect to individual indicators of public benefit outputs, and to system-type approaches including conservation agriculture/IPM and HNV farming in the absence of regulations (as for organic) or physical infrastructure (as for agroforestry).
13. Identify for all the above whether there are any specific gaps in provision associated with specific farm types or land uses, e.g. crofting or rough grazing, that might require further research and/or specific additional provisions

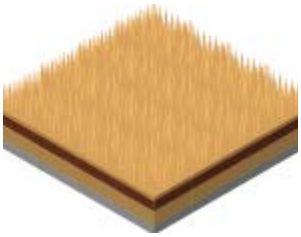
ANNEX 1: KEY TO FIELD TYPES IN SCHEMATIC ILLUSTRATIONS



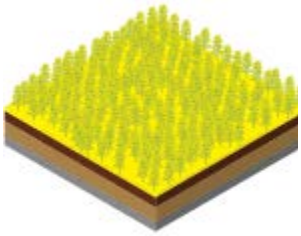
Barley



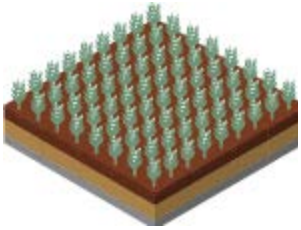
Wheat



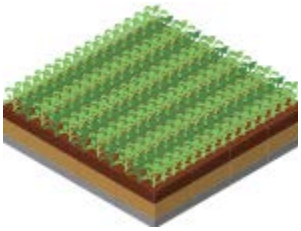
Oats



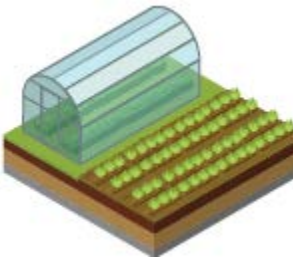
Oilseed Rape



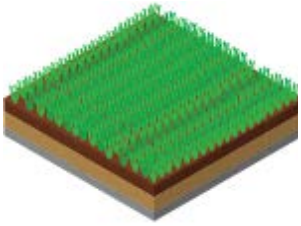
Field beans



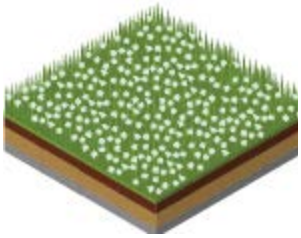
Potatoes



Horticulture



Fodder crops

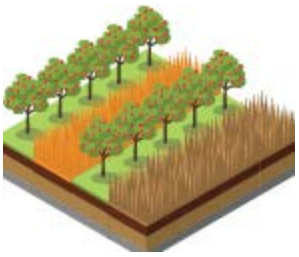


Rotational grass with white clover

Permanent (improved) grass – dairy

Permanent (improved) grass – beef

Rough grazing – sheep



Agroforestry – alley cropping (arable)

Agroforestry – hedge with trees (dairy)

Agroforestry – scattered individual trees (beef)

Agroforestry – rough grazing shelter belts (sheep)

Wood pasture (crofting)

Uncropped field margin

Habitat conservation

Nature restoration

ANNEX II: RESULTS-BASED PAYMENTS

Results-based payments (RBP) are environmental land management contracts where the annual payment per hectare is based on evidence of the environmental outcomes, in contrast to conventional agri-environment schemes where payment is based on evidence of prescribed management actions having taken place. RBPs are not new, but there is increasing interest in their potential as a delivery model for public funding, particularly to improve achievement of biodiversity objectives. RBPS have been widely used in Germany and France since the early 1990s to 'top-up' prescription-based grassland agri-environment schemes. The success of the well-known Burren Programme[56], a standalone RBP scheme used successfully since 2010 in western Ireland, has created widespread interest in 'pure' RBP schemes.

The key feature of RBP is that the payment received is directly linked to the level of environmental outcome achieved on that land (not to the management inputs/actions undertaken). This means that farmers who are already providing high quality biodiversity management can be rewarded for this, which is important because declines in species-richness and habitat quality can be difficult to reverse. In the Scottish context this also addresses the point made by the case study crofters that they have never been rewarded for the public goods they are delivering at present. The tiered result/payment structure now commonly used for RBP schemes means that all participants have a clear financial incentive to improve and maintain their biodiversity management.

The inherent strengths of RBP, compared to prescription-based payments have been defined as[57]:

- the payment/result link focuses farmers' attention on owning and understanding the results, promoting genuine behaviour change;
- RBPs are more environmentally cost-effective because payment is made only when results are delivered, and payments can be structured to encourage achievement and maintenance of higher environmental outcomes;
- there is no need for the paying agency to verify that individual prescriptions have been fulfilled;
- farmers are free to use their own local knowledge and expertise to make management decisions that achieve results in their specific location – the onus is on the farmer to seek advice and to improve their skills and knowledge to enable them to deliver the results;
- the absence of prescriptions provides flexibility at the field, farm, local and regional level and can bridge the gap between the delivery efficiencies of a 'one size fits all' national scheme and the need for local flexibility in delivering environmental objectives; and
- RBPs offer an opportunity to simplify payment schemes focused around clear environmental objectives, without the need for add-on supplements and environmental grants as these can be embedded as tools supporting the delivery of the RBP objective.

Over the period 2014-19, the EU funded on-farm RBP pilot projects to test and evaluate the design, implementation, control and verification and cost-effectiveness of standalone RBP schemes. These pilots ran for two or three years in a total of six locations within HNV farming systems (in most cases, Natura 2000 sites) in Ireland, England, Romania and Spain. Their

[56] http://burrenprogramme.com/

[57] Chaplin, S., Robinson, V., LePage, A., Keep, H., Le Cocq, J., Ward, D., Hicks, D. & Scholz, E. 2019. *Pilot Results-Based Payment Approaches for Agri-environment schemes in arable and upland grassland systems in England.* Final Report to the European Commission. Natural England and Yorkshire Dales National Park Authority.

location specific biodiversity objectives included: habitat for breeding waders; species-rich hay meadows; species rich flood meadows (with a variant, habitat for ground-nesting birds); species-rich grassland (with a variant, habitat for Marsh Fritillary butterfly) and, in Spain, traditional HNV permanent crop mosaics. In a seventh location, in East Anglia, the pilot covered two arable RBP schemes: provision of pollen and nectar sources for pollinators, and provision of winter bird food. The pilots involved farmers who had no previous experience of agri-environment schemes, or experience only of prescription-based schemes.

The results of the pilots have shown so far[58] that:

- the RBP measures tested in England, which has a tiered result/payment structure with between five and ten levels, significantly out-performed control plots in equivalent conventional agri-environment schemes with a flat-rate payment;
- in both England and Ireland, the RBP pilot farmers were motivated to change their management in a way that translated into higher scores;
- the Ireland farmers, on the whole, viewed RBP as a fair mechanism for delivering agri-environment funding, and were hopeful that it would be rolled out more widely in future for farms with a high proportion of semi-natural grassland;
- in all the pilots targeted, advisory support was important in building farmers' understanding of the biodiversity objective and the impact they had on it, building their confidence in adopting the RBP approach, and helping them to make decisions about the appropriate management to improve their results; and
- although the pilots did not have the resources to undertake a full comparison of cost-effectiveness, estimates suggest that in terms of delivery costs for the managing authority, the administrative simplicity of the RBP approach offset the additional advisory resources required to support the ongoing implementation.

The most recent developments in RBP biodiversity schemes include a number of new pilot schemes in other EU countries and the large-scale Hen Harrier project in six areas of Ireland, launched at the end of 2017 under the EIP Operational Programme measure of the RDP. This has a budget of €25 million, of which 83% is payments to farmers, and by mid-2019 had more than 1,500 farmers and 37,000 ha under contract. There has been a 35% increase in Hen Harrier chicks fledged compared to the 2017 baseline. Persecution of the species has effectively ceased, and active opposition to designation has been greatly reduced. The scheme assesses 18,000 fields annually using specialist computer technology, with 100% remote inspection of claims in addition to a minimum of 5% field inspections[59].

RBP schemes appear to offer a significant opportunity to support extensive HNV farming and crofting systems by rewarding and improving the delivery of biodiversity-related public goods otherwise likely to be threatened by abandonment or afforestation, while at the same time stabilising the economic viability of these vulnerable farms, with consequent social and economic benefits for the wider communities in which they lie.

[58] The England pilots continue as part of Defra's Tests and Trials Programme.
[59] Fergal Monaghan pers. comm. For more information see http://www.henharrierproject.ie/

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