FARMING FOR CLIMATE ACTION

What are we waiting for?

2022

Nature Friendly Farming Network

Contents

The UK is at a pivotal moment in time when momentous decisions in our food, farming and land use will dictate how effectively the urgency of the climate and nature crises is addressed. In all four corners of the UK, the impact of each decision will determine the viability of farming's future. And while each country is different in their approach and every farm will differ in the systems they choose; all must come from a place of total conviction in adopting meaningful measures that deliver real climate action.

In 2009, the UK Government committed to an 80% reduction in net Greenhouse Gas Emissions (GhGs) by 2050, which was amended under the Climate Change Act in 2019 to commit the UK to meeting net zero by 2050. This means that GhG emissions need to be equal to or less than emissions removed from the environment[1]. Such an ambitious target is necessary in reducing emissions that are directly causing the greenhouse gas effect, and in turn, causing climate change.

But it cannot be overstated: this is no small task. Agriculture is the fourth largest contributor to total UK GhGs after energy, transport, business and residential construction sectors[2]. Agriculture, alongside forestry and other land use, were collectively responsible for 12% of UK GhGs in 2019, with emissions from agriculture (including livestock and agricultural soils) making up 11% of UK emissions in 2019[3].

The emissions from agriculture are understandably in the spotlight when it comes to climate change mitigation, driven by this overarching net zero target. However, farming's contribution to the degradation of the natural environment has made landscapes less able to naturally sequester and store carbon while ecosystems are less resilient to the impacts of global warming.

While on-farm action is urgently needed to reach net zero, it is vital that a reduction in farming's emissions is not the only focus for climate mitigation, nor should it come at the expense of climate resilience.

Climate resilience – which is achieved through the restoration of the natural environment – will provide landscapes with the necessary protection to withstand the pressures of a changing weather system, while simultaneously enabling efficient carbon sequestration and storage through natural processes. This is as equally important to achieving net zero and cannot be overlooked in measures to offset carbon. Biodiversity restoration and the carbon potential of well-managed habitats, including soils, grasslands and hedgerows, must be balanced carefully with land use strategies for decarbonising.

But the context within which farmers are currently addressing this challenge is fraught with uncertainty. From the future of agriculture regulation and payment schemes, to trading negotiations and changing consumer demands - it is extremely difficult to plan and make decisions about the future. Combined with the criticism around farming's role in contributing to climate change, it is no surprise that confusion and fear is often the dominant response to the scale of the challenge at hand.

Yet what remains absolute is the positive role that agriculture can play in helping achieve the UK's climate ambitions – but only when farming and land use is part of the solution.

This paper aims to give an overview of the direction of travel in UK-wide policy, while looking at the sources of agriculture's GhGs, the role of Nature-based Solutions (NbS) in helping to store and capture carbon, and how step changes towards a whole-farm approach holds the greatest potential for long-lasting change.

The benefits of acting towards reducing GhGs and capturing carbon in land are significant, with the onset of new incentives through government schemes and the invaluable benefits of working with nature to support farming profitability – whether by spending less on nitrogen fertiliser, bought in livestock feed, managing pests naturally or by maintaining healthy soil.

Despite differing constraints and priorities, there are a range of actions available to every farmer, crofter and land manager, regardless of size or system. This report concludes with an infographic of eight management processes which can unlock multiple benefits for climate, nature and farm businesses.

The enormity of the challenge and the severity of the consequences make every decision in future farming and land use pertinent and every practice that is adopted and adapted matter – as on-farm choices help to build pressure for positive change.

Government climate change targets, policies and incentives

The Climate Change Act 2008 was amended through secondary legislation in 2019 to commit the whole of the UK to a target of net zero. Legislation in Wales and Scotland commit to achieving net zero by 2050 and 2045 respectively. In Northern Ireland, climate change legislation has yet to be passed, although the NI Executive have committed to passing domestic climate legislation as part of the New Decade New Approach Agreement. A clear direction of travel towards net zero has been set.

The UK joined over 100 other signatories to the Global Methane Pledge commitment to a collective goal of reducing global methane emissions by at least 30% from 2020 levels by 2030[4]. This is a non-binding pledge and none of the four UK countries currently have specific policies or targets dedicated to methane reduction, so it is currently not possible to say how this will directly affect the agriculture sector. If strategies are developed to help realise this pledge, commentators are clear that they will need to include improved methane inventory calculations, dietary shifts as well as reducing livestock numbers and improving efficiencies of livestock (e.g. through feed additives)[5][6].

Besides these pledges and targets, policies and funds are being developed and implemented across the four countries to make net zero feasible. Table 1 compares government targets for climate and nature across England, Scotland, Wales, Northern Ireland and the UK.

In **England**, Environmental Land Management (ELM) schemes are being developed to deliver a key purpose of the 2020 Agriculture Act to manage land, water or livestock in a way that mitigates or adapts to climate change. In its recent Net Zero Strategy, the UK government set a target for 75% of farmers in England to be engaged in low carbon practices by 2030, rising to 85% by 2035[7]. In addition to ELM schemes, the Nature for Climate Fund, Farming Investment Fund and the Farming Innovation Programme are funds to support action. Defra's Clean Air Strategy includes a target to reduce ammonia by 16% by 2030[8] and the Nutrient Management Expert Group, due to report in spring 2022, will advise the UK Government on the optimal policy approaches to minimise emissions from fertiliser use[9]. A Soil Health Action Plan for England (SHAPE) will be consulted on in Spring 2022[10].

In **Scotland** in 2019, the Scottish Government revised their Climate Change Act's greenhouse gas (GHG) emission targets to a reduction of 75% by 2030, 90% by 2040 in comparison with 1990 levels, and net-zero by 2045. The Act also embedded the principles of a Just Transition. Scotland has committed to increasing the area of woodland in Scotland to 21% with a set annual woodland creation target of 18,000 hectares (inc 4000 hectares of native woodland creation) per year by 2024/5, and to provide funding to enable at least 20,000 hectares of peatland restoration per annum. Scotland is currently working towards a new Agriculture Bill. This will be introduced in 2023 to deliver a new support framework that will include delivering climate mitigation and adaptation, nature restoration and high quality food production and the integration of enhanced conditionality against public benefits, with targeted outcomes for biodiversity gain and low emissions production. It is also working towards the introduction of a Good Food Nation Bill (2022), a Natural Environment Bill with legally binding targets (2023) and a Circular Economy Bill (2023.)

In **Wales**, the Senedd passed a suite of regulations in March 2021 to increase Wales' decadal emissions targets from those set in 2018 with a commitment to reach net zero by 2050[11]. The Agriculture (Wales) Bill is expected to be introduced to the Senedd in 2022, alongside the publication of a draft Sustainable Farming Scheme. This new scheme, expected to open in 2025, will require all farms across Wales to reduce on-farm emissions through improved livestock, land and nutrient management, as well as rewarding carbon sequestration through Nature-based Solutions[12]. Net Zero Wales commits 10% of agricultural land to be shared to support tree-planting by 2050 and over 3,000 hectares of Peatland to be on a 'recovery pathway' by 2025. It also encourages people to consider their diet and to eat healthier, more sustainably sourced food and to actively consider the positive impacts of eating locally sourced food and minimising food waste[13].

Northern Ireland does not currently have a legislative target for achieving minimum GhG reductions. However, a Climate Change Act is expected to be passed as part of the current Assembly mandate, with an ongoing debate on the eventual target that will be set. The Department for Agriculture, Environment and Rural Affairs (DAERA) is currently developing a Green Growth Strategy which aims to secure climate and environmental objectives alongside the creation of 'green' jobs. The Forests for our Future programme aims to plant 18 million trees by 2030 to create 9,000 ha of new woodland, while a draft peatland strategy and Food Strategy Framework have been consulted upon recently. The process of developing post-Brexit agriculture policy is also taking place, but as yet it is unclear how future schemes and farm regulation will contribute towards efforts to achieve climate commitments at domestic and UK levels.

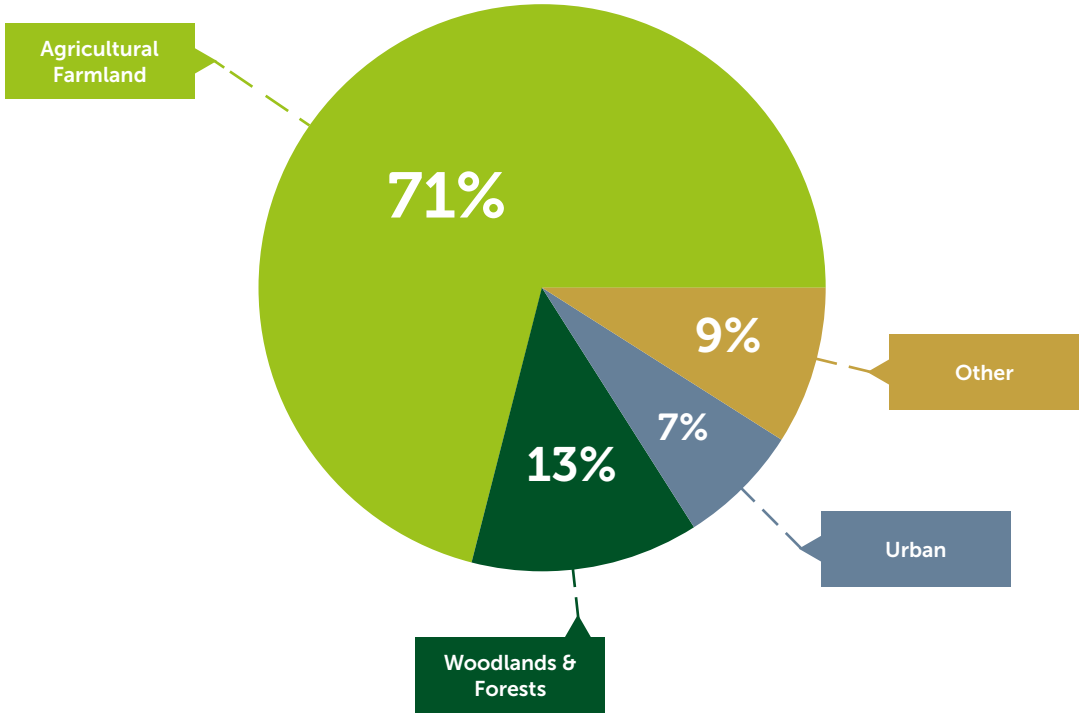
Table 1: Comparison of devolved & UK government targets for climate and nature

	England	Scotland	Wales	Northern Ireland	UK
Ammonia Reduction	As per UK[14]	As per UK[15]	As per UK	As per UK[16]	16% reduction by 2030[17]
Methane Reduction	As per UK	As per UK	As per UK	As per UK	30% reduction from 2020 levels by 2030[18]
Nature Recovery	Species decline halted by 2030[19] At least 30% of land and sea protected for nature by 2030[20]	30% of Scotland's land and seas to be protected (with 10% highly protected by 2030)[21]	As per UK	As per UK	'30by30' commitment to protect 30% of land and seas for nature by 2030. Halt and reverse biodiversity loss by 2030[22]
Peatland Restoration	35,000ha peatlands restored by 2025[23]	250,000 ha restored by 2030[24]	3-4000ha by 2025 (600-800ha p/a between 2020-2025)[25]	All peatlands supporting semi-natural vegetation managed for biodiversity & ecosystem function by 2040[26]	2 million ha of peatland in good condition, under restoration, or sustainably managed by 2040[27]
Water Restoration	All water bodies to reach good ecological status by 22nd December 2021[28][29]	87% of water bodies to reach good ecological status by 2027[30]	All water bodies to reach good ecological status by 22nd December 2021[28][29]	70% of water bodies at 'good or better status' by 2027[31]	The EU's Water Framework Directive drives water quality targets across the UK
Woodland Creation	New woodland: treble woodland creation rates by end of this Parliament[32]	New woodland: 12,000 ha p/a to 2024; 18,000 ha p/a year by 2024/25, continuing to 2030[33]	New woodland: 43,000 ha by 2030 180,000 ha by 2050[34]	New woodland: 9,000 hectares of new woodland by 2030[35]	New woodland: 30,000 hectares per year by the end of this Parliament[36]
Food Waste	As per UK[37]	Reduce Scotland's food waste by 33% by 2025[38]	Halve food waste by 2025 and 60% by 2030[39]	As per UK[40]	UK as part of the UN is committed to UN Sustainable Development Goal 12.3 which sets a target by 2030 to reduce by 50% global per capita food waste and reduce food losses along production and supply chains, including post-harvest losses[41]

The Lay of the Land: Farming in the UK

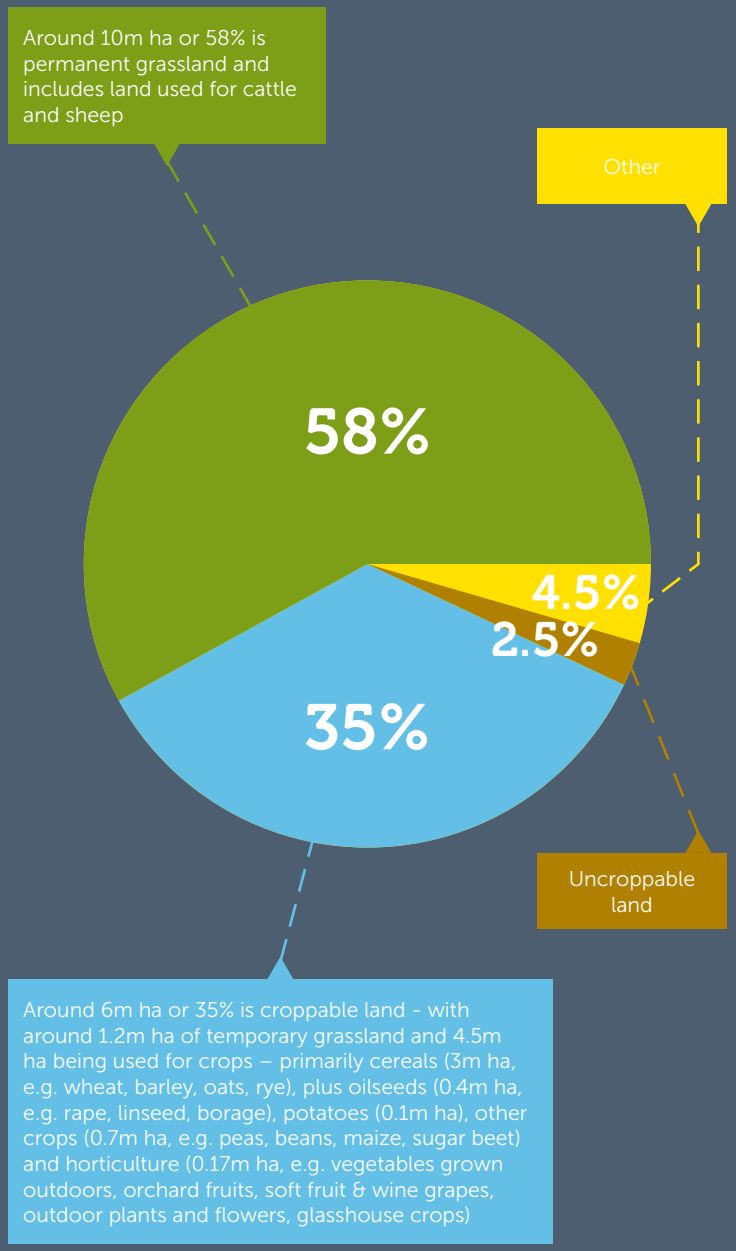
Agriculture contributes 0.5% to the UK's economy and around 300,000 people work on agricultural holdings[42]. The UK is around 61% self-sufficient – so the UK grows around 61% of the food it eats[43]. Whilst the UK imports £10 billion worth of meat and milk per year, it also exports £4 billion[44].

Area of UK land that is used for agricultural farmland.



Farmland comprises nearly three quarters (71%) of the total area of the UK equalling 17.3 million hectares. This land is made up of arable and horticultural crops, uncropped arable land, common rough grazing, temporary and permanent grassland and land used for outdoor pigs and poultry. It does not include woodland and other non-agricultural land[45].

Breakdown of UK agricultural land use[46]



There is great difference between the four UK countries in farming (see Table 2). For example:

The amount of land that is mainly or fully tenanted varies by nation with 28% in England, 24% in Scotland and 22% in Wales. In Northern Ireland, around 30% of land is let in conacre - short term rental of up to 11 months[47].

In Scotland, around 80% of land is used for agriculture, with 44% classified as High Nature Value[48]

In Wales, land used for agricultural purposes accounts for 88% of the total land area with the majority of this being permanent grassland or rough grazing. There are 10m sheep and lambs in Wales (which is over three times the population of Wales).

In Northern Ireland, around 75% of land use is devoted to agriculture with 95 percent of farmland providing grass and rough grazing for beef, sheep and dairy leaving only 5 percent for crops[49]

England has a smaller area of farmland than the rest of the UK (69%) with a higher proportion of croppable land (54% of farmland, or 4.9m ha) which is predominantly cereals and oilseed rape (79%)

Table 2: Land used for agriculture and livestock numbers

	Utilised Agricultural Area (UAA)	Total croppable area (hectares)	Permanent grassland (hectares)	Rough grazing (hectares)	Woodland (hectares)	Cattle & calves (million)	Sheep & lamb (million)	Pigs (million)	Poultry (million)
UK[50]	17.3m hectares 71% of land	6m	10m	1.19m 'common rough grazing'	1m	9.6	32.7	5.1	182
England[51]	8.8m hectares 69% of land	4.9m	3.5m	399,000 *'common rough grazing'*	379,000[52]	5	15	3.7	139
Scotland[53]	5.64m hectares 80% of land[54]	588,801 *'total crops & fallow'*	1.13m *'grass over 5 yrs'*	3m	550,400	1.7	6.8	0.3	14
Wales[55]	1.59m hectares 88% of land[56]	90,144 *'total crops and fallow'*	1m	248,678	92,770	1.1	10	0.2	7.5
Northern Ireland[57]	1.03m hectares 75% of land[58]	45,562 *'total crops'*	674,833	140,581	17,276	1.6	1.9	0.7	24.4

Greenhouse Gas Emissions

Greenhouse gas emissions (GhGs) are comprised of three main gases: carbon dioxide, nitrous oxide and methane. Of agriculture's GhG emissions, the latest Committee on Climate Change assessment calculated that nitrous oxide (N2O) accounts for 31% and methane (CH4) 56%[59]. In contrast, agriculture only accounted for about 1.7% of total carbon dioxide (CO2) emissions in the UK[60].

In global accounting GhG emissions are calculated on a nation-state basis. The life-cycle emissions from imports ('consumption emissions') are not factored into UK accounts, but they make up 46% of the UK's total carbon footprint[61].

Whilst agricultural emissions have shown an overall 16% decrease across the UK between 1990 and 2018, an increase of 2% was reported over the period 2008 - 2018, signalling that progress towards net zero may at best be slowing, and at worst reversing based on most recent data[62].

Emissions from agriculture vary across the UK. Agriculture accounted for 12% of Welsh GhGs in 2016[63] whilst in In Northern Ireland the figure was 27% of all emissions in 2016[64]. In Scotland agriculture contributes around 25% of all emissions[65] whilst the average for the whole of the UK's land use sector (agriculture, forestry and peatland) is 12%[66].

The main sources of GhGs in each farming system are looked at in turn below.

Arable & horticulture

Increases in crop production have simplified and shortened crop rotations in cereals (e.g. wheat and maize) and oilseed crops in particular. This has been coupled with an increase in nitrogen-based (N) fertilisers, a reduction in the use of legumes in cropland which further increases N requirements due to the absence of nitrogen-fixing crops, an increase in crop exposure to pests and weeds[67] due to the lack of diversity inherent in monoculture, and downward pressures on biodiversity and soil health.

For arable farming systems, the main GhG emissions stem from the manufacture and application of N fertiliser[68]. Fertilisers applied to soils grow crops and grass for human food, animal feed and biofuels.

N fertilisers contribute to climate change in two major ways: from fossil fuel-reliant manufacture and from GhGs released by their application. N fertilisers emit the potent GhG nitrous oxide (N2O) which is 300 times more warming than CO_2[69]. In Europe, animal feed accounts for 80% of all nitrogen inputs, largely in the form of synthetic fertiliser[70]. Growing biofuels can contribute to soil erosion and nutrient runoff - and are reliant on N fertilisers. The nitrogen balance measures how much of the nitrogen fertiliser applied to crops is lost to the environment. Provisional estimates for 2019 show that the nitrogen balance for the UK was a surplus of 84 kg/ha on managed agricultural land[71].

Agriculture is the major source of nitrous oxide (N2O) emissions in the UK, accounting for nearly 68% of total N2O emissions 2019, with nearly 90% of agricultural N2O emissions coming from soils, particularly because of N fertiliser application (and over-application), manure (both applied and excreted on pasture) and leaching/run-off[72]. The environmental impacts of N fertiliser and manures use include water quality (nitrogen and phosphorous levels in waterbodies), air quality (ammonia emissions) and climate change (nitrous oxide emissions)[73].

An estimated 9.8 billion tonnes of carbon are stored in the UK's soils, making them an essential resource to reduce GhGs and tackle climate change[74]. Soils store carbon but if managed badly emit it instead. Common farming techniques such as monocropping, using N fertiliser to improve yield, mechanical tillage, heavy farm machinery, exposed soil (e.g. soil not covered in cover crops), over-grazing, fewer trees and hedgerows on farms and draining waterlogged soils such as lowland fens have all contributed to declines in soil health.

Livestock-based systems: cattle & sheep, pigs & poultry

Most methane emissions (87%) originate from ruminants as part of their natural digestive process (enteric fermentation), so almost half (49%) of all agricultural emissions come from ruminant livestock[75].

Methane is a potent GhG but in comparison to nitrous oxide it is relatively short-lived in the atmosphere. Nitrous oxide is in the 'long-lived' category, persistent for an average of 114 years in the atmosphere and up to 300 times more potent than carbon dioxide.

For livestock-based systems the main emissions are methane produced via enteric fermentation for ruminants, and emissions associated with feed production for pig, poultry and, in certain circumstances, dairy systems[76].

Protein consumption in the UK is higher (by around 70%) than that recommended by WHO guidelines for a healthy diet[77]. In the UK, in terms of land use for food, grasslands take up 63%, feed crops 22% and food crops 15% of land. Livestock therefore takes up 85% of the UK's total land use for food; and it provides 32% of the population's calories[78]. In 2019 the UK imported 1 million tonnes of soya for livestock feed from high deforestation risk areas[79].

However, adopting livestock management systems which work in harmony with nature can bring many benefits to the farm landscape, and when managed appropriately, ruminant livestock play a significant role in reversing environmental damages. Livestock management decisions such as scaling herd size to match the natural carrying capacity of the land, alongside balancing grazing duration and frequency, will reduce environmental impact at the same time as providing essential ecosystem services. Pasture-based systems, where animals are free to roam and graze through sensitive grazing regimes, such as rotational and mob grazing, can restore soil health and carbon sequestration by minimising the damage of tillage, reducing the need for inorganic fertilisers through manure, and in turn, improving soil ecological function and enhancing biodiversity[80].

Mixed farming systems

Integrating ruminant livestock into arable rotations can play a positive role in climate mitigation and well-managed mixed farming systems can provide multiple benefits including the benefits of appropriately managed livestock as listed above. Mixed farming systems have the additional benefits of improved soil health and fertility by providing nutrient cycling and availability through the introduction and use of rotations between crops, such as forage legumes. By making use of crop residue and animal manure, rotational grazing can maintain and improve soil health. Employing appropriate livestock management will reduce tillage and soil disturbance, whilst eliminating or reducing the use of inorganic fertilisers. Livestock can also help control weeds or parasites and reduce the need for chemical weed and pest control through good pasture management[81].

Changes to the way fertiliser, crops, soils and livestock are managed will be critical in reducing GhG emissions from agriculture. Changing farming practices is only one side of the coin for farmers on the journey to net zero though. The other side is the potential of managing land so that it captures carbon and gives other benefits using Nature-based Solutions[82].

The Impacts of Global Warming on Agriculture

Agriculture will be one of the sectors most heavily affected by climate change. While the sector is a major source of GhGs contributing to global warming, the changing climate and increased frequency in extreme weather events will present enormous challenges to UK agriculture.

Studies show that temperatures in the UK could increase four-fold[83] with days exceeding 25.0°C rising from around 10 days a year to 37 days with a 4.0°C rise in global warming, whilst a 2.0°C rise in average global temperature would see the number of days exceeding 25.0°C almost double to 18 days per year. By 2080, climate change projections will lead to a decrease in overall Agricultural Land Classification grade quality compared to the baseline, with drought and dryness being the biggest factors[84]. Aberystwyth University's Institute of Biological, Environmental & Rural Sciences states that a continuation of the exceptional heat and drought of recent summers will make it unlikely that Wales can continue to support its sheep industry[85].

Increased rainfall will also become an issue, with the number of days of high-impact heavy rainfall in the UK leading to severe weather warnings potentially rising by three days per year. Currently, there are around 7 days per year in England and Wales with intense and prolonged rainfall that could lead to river flooding. With a 4.0°C rise in global temperature this could rise to 13 days per year. Under a 2.0°C rise in global temperature it is expected England and Wales will receive 10 days of intense and prolonged rainfall. A trend towards wetter winters is likely to increase problems such as soil compaction and erosion, unless good management practices are adopted[86].

Given the sheer size and scale of agriculture's land use and contribution to the UK economy, the impacts of climate change will be devastating if farmland does not build effective climate resilience to changing weather. As such, increasing the application of on-farm adaptation and mitigation strategies to manage the impact of climate change is of critical importance, with immediate inaction very likely to result in high costs later[87].

Nature-based Solutions

Natural habitats and the species that depend on them are in freefall. The UK has only half of its natural biodiversity left and is one of the most nature-depleted countries in the world[88]. The State of Nature (2019) reports that 41% of UK species are in decline and 133 species have been lost completely since 1950; and that over one in ten species (15%) is threatened with extinction with no signs of these trends slowing[89].

The UK has only half of its natural biodiversity left and is one of the most nature-depleted countries in the world

The UK has committed to the Leaders' Pledge for Nature, which has so far been signed by leaders from over 85 countries, and the '30by30' commitment to protect 30% of our land and seas for nature by 2030, agreed by more than 60 countries. At the G7 summit in June 2021, the UK also committed to 'halt and reverse biodiversity loss' by 2030. These commitments are consistent with many goals and targets of the emerging post-2020 Global Biodiversity Framework of the Convention on Biological Diversity[90].

On-farm habitats – from peatlands, woodlands and heathlands, to wetlands, saltmarsh and grasslands – act as Nature-based Solutions for climate if they capture carbon or provide adaptation to climate change effects, for example by reducing flooding. Natural habitats therefore both help to reduce GhGs and help farming businesses be more resilient and protected against the effects of climate change – from drought and flooding to wildfires and pests. As well as these climate benefits, they can enhance biodiversity, create improved and more resilient ecosystem functioning, enhance human wellbeing and provide economic benefits, in terms of monetary value and job creation[91].

Much of the UK's 2.6 million hectares of peatland is degraded

Peatlands

The UK's peatlands contain around 3,000 million tonnes of carbon. However, much of the UK's 2.6 million hectares of peatland is degraded and no longer actively sequesters carbon. Estimates suggest that UK degraded peatlands could be emitting 23 million tonnes of CO_2 annually (around 5% of the UK's GhGs). The overall UK target on peatlands is for 2 million ha of peatland to be in good condition, under restoration, or sustainably managed by 2040[92]. Each of the four UK countries has their own peatland restoration targets (see Table 1).

Based on current UK Government tree planting ambitions (30,000 hectares per year by 2025), an estimated 18.5 million tonnes of carbon dioxide equivalent emissions would be captured through new and existing forests annually, but not before 2050 to 2055. Action to stop emissions from degraded peatland must therefore go hand in hand with other Nature-based Solutions like tree planting[93]. Peatlands can be restored by rewetting and revegetation – with added benefits of natural flood management and water filtration as well as biodiversity.

Woodlands

Woodlands currently store 1.09 billion tonnes of carbon and sequester about 4.6% of the country's total emissions around three quarters of which is in the soil. The UK Government has a target to treble woodland creation rates in England, contributing to the UK's overall target of increasing planting rates to 30,000 hectares per year by the end of this Parliament. Each of the devolved nations also have their own tree planting targets (see Table 1). Depending on the choice of site, species and establishment method, these new woodlands could also benefit biodiversity and deliver multiple ecosystem services[94].

Agroforestry

Agroforestry is a land management approach that combines trees and shrubs with crop and livestock farming systems. This practice delivers a multitude of benefits both for the farm and for nature[95]. It provides carbon sequestration and storage estimated to be up to 63 tonnes of carbon per hectare due to increased presence of trees[96].

Hedgerows

Hedgerows are already a very important Nature-based Solution in farmed landscapes, with current estimated stocks of up to 100 tonnes of carbon per hectare (t.C/ha) in established hedge networks[97]. The Climate Change Committee has called for a 40% increase in the extent of hedgerows by 2050, equivalent to roughly 120,000 miles[98].

Grasslands

Taken together, grasslands store 2 billion tonnes of carbon, but this is vulnerable to disturbance

40% of the UK's land cover is made up of grasslands – including improved, semi-improved and semi-natural grasslands - all of which have differing potential to store carbon with low-input and unimproved grasslands generally storing more carbon. On average, unimproved grasslands sequester 230 tonnes/ha of soil carbon compared to 140 tonnes/ha stored in improved grasslands[99]. Taken together, grasslands store 2 billion tonnes of carbon, but this is vulnerable to disturbance. Between 1990-2006, arable conversion of grasslands released 14 million tonnes of CO_2.

Field Margins

Field margins taken out of production have soil carbon levels 37% higher than beneath an annual crop[100]. Field margins can also prevent erosion and water pollution and benefit wildlife including species that deliver important ecosystem services such as pollination and pest regulation.

Freshwater

Freshwater environments are rich in biodiversity and are especially sensitive to a changing climate; they also help manage the impacts of climate change – so looking after them is a top priority. Ponds can store high levels of organic carbon.

Proposals On How To Get To Net Zero

Several pathways to help achieve net zero through farming and land use have been produced, highlighting the myriad ways in which this goal could be achieved. Some focus on increasing efficiencies to free up land for large scale woodland expansion and peatland restoration, others have focused on technological solutions while there are those that emphasise dietary change and the large-scale adoption of agroecology as the solution. There are differences around the relative importance and substantive merit of carbon capture, biodiversity, diet change and changes in land use including in Nature-based Solutions. There are also challenges around how to measure GhGs and mitigations.

While several roadmaps have been proposed, each with their own benefits and limitations, it is abundantly clear food, farming and land use will undergo a period of massive transformation in the road to net zero.

The **Committee on Climate Change** (CCC) proposes land use changes which include around 9% of agricultural land being needed for actions to reduce emissions and sequester carbon by 2035 with 21% needed by 2050. This release of agricultural land is proposed to be met by improvements in 'agricultural productivity' (i.e. improvements in soil, livestock, waste and manure management)[101], and a trend towards healthier diets to release land for afforestation, peatland restoration and bioenergy crops[102]. The CCC's latest proposals are for diet change to reduce consumption of high-carbon meat and dairy products by 20% by 2030, with a further reduction of meat products by 2050 as well as reductions in food waste[103].

The CCC proposals for land use and agriculture have been criticised on several grounds including its focus on bioenergy crops which could come at the expense of biodiversity[104]. Their proposals may also miss opportunities to secure multifunctional landscapes that deliver more than simply net zero. An ambition to reach this target by being overly-reliant on technology and driving intensive areas of production without making systemic changes, will not create the holistic benefits of addressing the climate and nature emergencies hand-in-hand.

The NFFN endorses an agroecological approach to farming which ensures farming and food systems are resilient through the adoption of land use policies that treat climate change, biodiversity and human health as interconnected.

Biodiversity restoration and the carbon potential of well-managed habitats such as peatlands are considered in tandem with ways to reduce GhGs, whilst carbon offsetting is considered a last resort. We support a 'less but better' approach to reducing meat consumption, where the farming methods do not have negative impacts through intensification. Instead, there is a focus on the benefits that sustainable livestock can bring through positive models such as High Nature Value systems, conservation grazing, low-input, and mixed systems where livestock can help recycle nutrients and build soil fertility for other crops.

The NFFN supports diversifying the type of livestock systems on our land, e.g. through agroecological, silvopastoral and agroforestry systems. Moving to lower input, higher quality, extensive systems and reducing protein intake from meat and dairy must happen alongside support for growing the UK horticulture sector so it can expand into producing a higher volume of more varied crops such as pulses and nuts. Taking a landscape-scale approach and encouraging diversity on and between farms could facilitate new ideas and systems, for example, by involving several farms to create a mosaic of habitats and food production. These new approaches allow farmers to keep up with - and be responsive to - consumer demand for less and better meat, allowing UK farmers to remain firmly in the picture as consumers increase their environmental awareness.

What Do Farmers Think?

Whilst the route map to net zero is not yet clearly defined and differs across the UK countries, the legislation and targets already exist or are in development and policies, regulations, schemes and associated funding are emerging. People's food choices are changing, as the popularity of protein-rich, plant-based foods shows – the plant-based food and beverage market in the EU and UK grew 49% between 2018 and 2020[105]. Increasingly agri-businesses and retailers are asking that their farmers can demonstrate how they are using climate and nature-friendly practices.

Given the range of views on how to achieve net zero (which are often contradictory and usually complex), the uncertain trade environment, a lack of clarity on future farming policies and the lack of long-term budgetary commitments for future schemes, as well as under-developed incentive schemes to replace those under the Common Agricultural Policy, it is no wonder there is fear and confusion.

The NFFN recently found that 92% of farmers are concerned about the effects of climate change and 71% thought that the industry is currently not equipped and resourced to address climate and nature loss at the same time as sustainably producing food at scale. When asked what support farmers need to reach net-zero, responses included: *"More guidance on what needs to be done"* and *"Alongside targets, they need to provide multiple options as there is not a one size fits all solution for this"*[106].

A recent poll for the Prince's Countryside Fund found that 81% of farmers want to do more for climate change[107], though national statistics produced for Defra show a slightly different picture with the proportion of farmers considering GhGs to be either fairly or very important when taking decisions about their land, crops and livestock is 67% in 2021[108].

Just over half of farmers (56%) reported that they were currently taking action to reduce GhGs from their farm by way of recycling of waste materials from the farm (83%), improving energy efficiency (79%) and improving nitrogen fertiliser application accuracy (62%). For those not taking action to reduce GhG emissions, the most common reason given was that they were unsure what to do as there are too many conflicting views on the issue[109].

Farming For Climate Action: How To Start And Continue Your Journery

Above all, action is as much in the hands of farmers, crofters and land managers as it is in the hands of decision-makers.

Whatever the farming system and approach, there are many ways to both reduce GhG emissions and capture carbon in the land farmers manage. The actions outlined in this report aim to help those who are unsure of where to start, as well as those already on the journey, and will offer some clarity on the practical steps to take.

Table 3 and accompanying infographic show:

- Four areas which are mainly about GhG emission reductions (fertiliser, crop, soil and livestock management)
- Three areas which are about capturing carbon through Nature-based Solutions and being more resilient to climate change (trees and hedgerows, habitat management and water management)
- And one area which is about looking at your whole farm and taking a whole-farm approach to planning and management for the benefit of climate, nature and your bottom line

Each of the eight areas has three suggested actions that can be taken based on evidence reviewed across different farming systems for this report. The benefits of acting are also highlighted in the table – both for climate and for farmers.

The natural assets within this table offer fundamental systems that underpin farming's productivity and the health of these systems is vital in securing farming's viability in the face of a changing and unpredictable climate. The provision of clean water and air, healthy and sustainable food production, lowered emissions, naturally captured and stored carbon, improved soil health and resilience against flooding and drought all benefit the farm business.

We hope this inspires you to take action for climate – and in doing so for nature and for your business.

To help on the journey, a fourth table (Table 4) is included to help get you get started with your planning. This can also be downloaded from the Resources section of the NFFN website.

Water management

- Buffer & protect watercourses
- Plan & manage to prevent flooding & drought
- Re-wet & create new wetlands

Fertiliser use

- Create a nutrient management plan
- Lock nitrogen into soil
- Use organic manures & slurries to meet soil & plant needs

Crop management

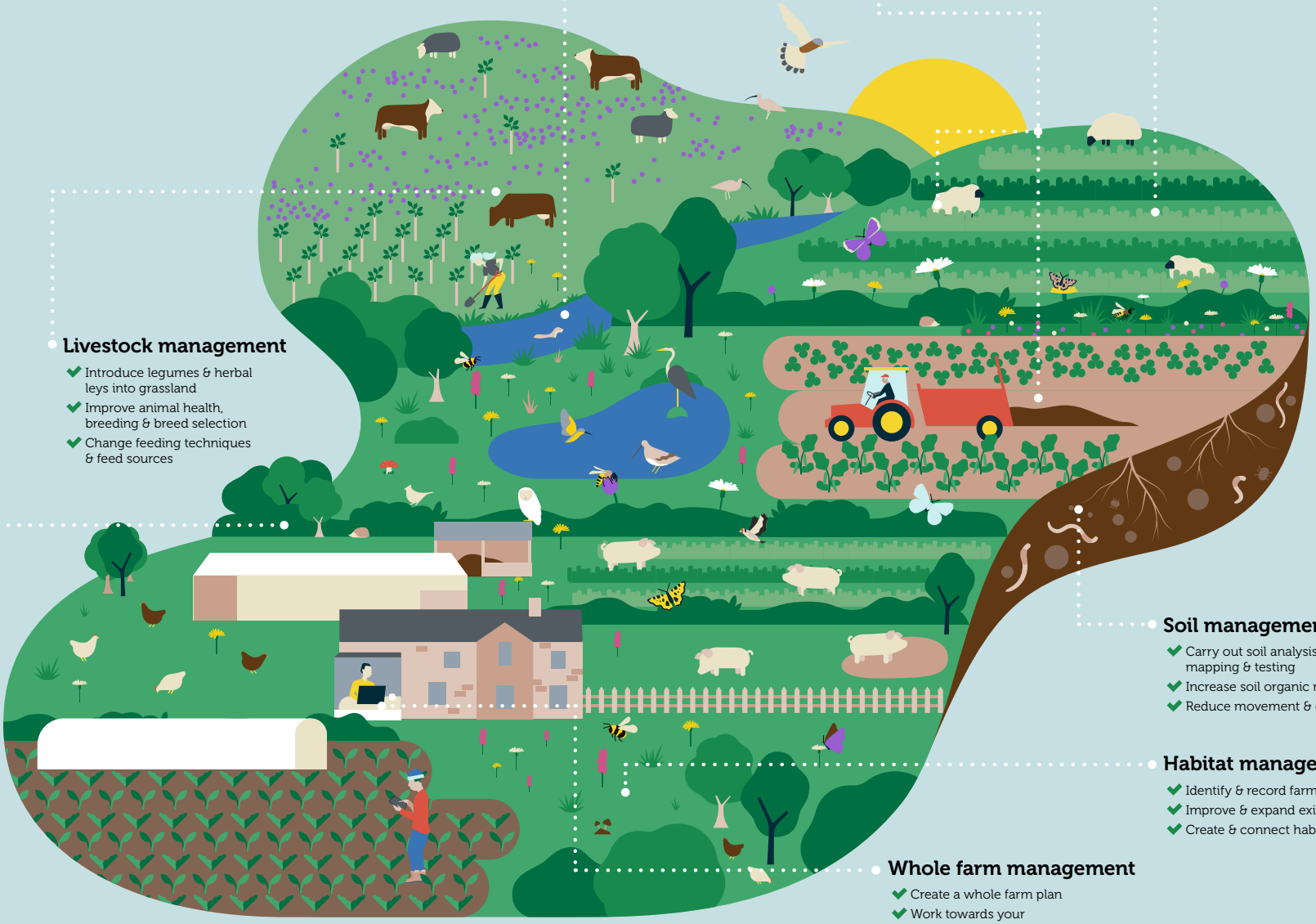
- Use catch & cover crops
- Consider cultivating land for crops in spring not autumn
- Increase diversity into crop rotations

Trees & Hedgerows

- Fill in gaps in hedges & increase hedge width
- Manage existing woodlands
- Plant new trees & hedgerows

Livestock management

- Introduce legumes & herbal leys into grassland
- Improve animal health, breeding & breed selection
- Change feeding techniques & feed sources



Soil management

- Carry out soil analysis, mapping & testing
- Increase soil organic matter
- Reduce movement & disturbance

Habitat management

- Identify & record farm habitat
- Improve & expand existing habitats
- Create & connect habitats

Whole farm management

- Create a whole farm plan
- Work towards your Maximum Sustainable Output
- Review your farming systems
- Consider undertaking a farm carbon audit

Table 3: Climate actions and benefits

	Action 1	Action 2	Action 3	Benefits for you
Fertiliser Use	Create a nutrient management plan to identify how to minimise artificial fertiliser application	Lock nitrogen (N) into soil by using catch & cover crops and prevent the loss of fertile topsoil and nutrients. Plant species that require less N fertiliser or will 'fix' N into the soil e.g. legumes such as clover, vetches, trefoil, sainfoin or lucerne	Use organic manures & slurries instead of synthetic N-fertiliser. Review your domestic regulations on storage and use of organic manures, slurries and synthetic fertilisers	• Less vulnerable to market forces, e.g. current high price of N fertiliser • Soil fertility improves with less N fertiliser • Reduce the need for pesticides: N fertiliser fosters fungal diseases and weeds – which need pesticides • Improved biodiversity • Improved water & air quality with a reduction in run-off • Reduction of emissions
Crop Management	Use catch & cover crops to reduce nitrate leaching, reduce soil erosion risk, improve soil structure and provide an N source to the following crop	Cultivate land in spring not autumn for spring cropping to avoid stimulating the mineralisation of N from organic matter when there is little N uptake by the subsequent crop, resulting in increased nitrate (NO3) leaching	Increase diversity and duration into your crop rotations by introducing legumes in arable rotations and grass leys and livestock onto arable farms	• Funding may be available via government incentive schemes for catch & cover crops • Crop rotations help to prevent disease and pest outbreaks in annual crops • Complying with regulation on soil erosion, leaching and run off • Improved biodiversity, soil health & weed management through livestock grazing • Reduces reliance on synthetic fertilisers with a reduction in cost
Soil Management	Carry out soil analysis, mapping & testing. Routinely analysing soil is a first step in effective decision making on soil health - apps to support you include the SOCiT App, Farm Crap App and Soil Mentor App	Increase soil organic matter by using animal manure and certified composts in place of N fertiliser, bringing livestock onto arable farm grass leys, using green manure, using cover and undersown crops	Reduce soil movement & disturbance by using lighter machinery, trying reduced till/no till farming, avoiding over-grazing, avoiding trafficking over and grazing wet land. On peat soils, less disturbance helps increase organic matter in soils vulnerable to oxidation	• Healthy soil is a valuable long-term asset • Soil compaction can lead to increased surface run-off as well as drought stress, fewer grazing days, poor root growth and reduced yields overall • Incentives available through England's Sustainable Farm Incentive for creating a soil management plan, increasing soil organic matter and for reducing soil compaction. Future schemes in devolved nations are likely to place more emphasis on good soil husbandry and associated environmental benefits • Comply with regulations
Livestock Management	Introduce legumes & herbal leys into grassland which reduces the need for nitrogen fertiliser	Improve animal health, breeding & breed selection to increase fertility, growth rates and reduce morbidity. Consider using low-input native breeds which can be outwintered. Match the stocking rates to the natural carrying capacity of the land	Change feeding techniques & feed sources by pasturing feeding or using home-grown protein sources for animal feed, co- and by-products in livestock feeds, and new technology (e.g. precision feeding). Reduce use of imported feedstocks. Consider changing grazing patterns, e.g. rotational or mob grazing	• Adapting to changes in demand: consumers are moving towards less but better meat production and higher-welfare animal products • Prepared for the marketplace: retailer and supplier requirements for net-zero production methods • Improved profitability in the medium- long-term by reducing costs & being less reliant on market forces (e.g. imported feed) • Comply with regulations

	Action 1	Action 2	Action 3	Benefits for you
Trees and Hedgerows	Fill in gaps in hedges & increase hedge width. Allow hedges to grow taller and wider and ensure flowering plants are allowed to grow around hedgerows at the field margin. For biodiversity, coppice no more than half of a hedgerow for wood fuel & no more than 5% in any year	Manage existing woodlands by creating & following a woodland management plan and by working with nature and natural processes to enable successive generations of trees and shrubs to adapt to climate change	Plant new trees and hedgerows. Start by getting advice on the possibilities available for tree planting on your farm and create a management plan	• Carbon capture • Financial incentives available • Improved biodiversity & habitat connectivity • Natural pest management • Flood risk management • Improved water quality • Improved soil health and quality • Improved animal health, fertility and reduced morbidity when trees introduced into livestock systems (and vice versa) • More stock-proof, reliable field boundaries
Habitat Management	Identify & record farm habitat. Understand the potential and take stock of what you already have by identifying and documenting the current habitats on your farm and creating a habitat map	Improve & expand existing habitats by following the habitat map improving and expanding the habitats you already have, e.g. linear features like hedgerows; wet features such as ponds, ditches and water courses; field and riparian margins; meadows; and even scrub. Improve areas of natural & semi-natural habitat	Create and connect habitats to achieve more for nature and climate. Consider working with neighbours and local advisors to identify priorities for nature restoration. Engage with local Councils to understand species and habitats to support in your area & enter land management schemes which encourage landscape-scale projects	• Carbon capture • Financial incentives available • Improved biodiversity & habitat connectivity • Natural pest management • Flood risk management • Improved water quality • Improved soil health and quality • Resilience to changing climate (e.g. pest and disease outbreaks) and extreme weather events (drought, flooding, wildfire)
Water Management	Buffer and protect water courses by establishing grass and/or woodland buffer strips alongside watercourses, or sensitive habitats, to intercept any overland flow, trap sediment, pesticides & prevent access for livestock	Plan & manage to prevent flooding & drought. Soil, crop & habitat management actions plus tree planting will support this. Monitor and appropriately maintain field drains and ditches. Identify places where run-off happens & manage impacts. Harvest & store rainwater	Re-wet and create new wetlands. Consider constructing a wetland or sustainable drainage system (SuDS) which can reduce localised flooding, trap/treat pollutants and provide a wetland habitat. Re-wet peatland soils	• Financial incentives available • Improved biodiversity • Protecting natural assets and farm infrastructure, which provides resilience to changing climate and extreme weather events, such as drought, flooding, wildfire • Carbon capture • Comply with regulations
Whole Farm Management	Create a whole farm plan Look at existing opportunities and constraints for your land, and the surrounding land. Create a whole-farm plan which looks to the future and factors in potential changes coming from climate change (e.g. drought, flooding, rising temperatures, pests and disease) and which seeks to work with farmers, foresters and land managers in the surrounding landscape	Work towards your Maximum Sustainable Output. Use the work of the NFFN and Nethergill Associates to consider getting advice from a trusted advisor to support you in reviewing your MSO and considering how profitability could be linked to your partnership with nature	Review your farming systems and find the best within your own system. You may want to consider whole system change, e.g. pasture-fed livestock, agroforestry, organic, paludiculture or agroecology	• Stop production being pushed beyond the limits of the landscape – or risk nature and farm businesses being wiped out • Getting a balance between food production and nature means and farming businesses are more profitable

Table 4: Getting started

	Action 1	Action 2	Action 3	Benefits for you
Fertiliser Use				
Crop Management				
Soil Management				
Livestock Management				

	Action 1	Action 2	Action 3	Benefits for you
Trees and Hedgerows				
Habitat Management				
Water Management				
Whole Farm Management				

Glossary

For a list of terms and practices explained in simple, straightforward language, visit **'A-Zero: A farmer's guide to breaking free from environmental jargon'** by the Prince's Countryside Trust. This booklet is aimed at farmers and hopes to make the language around environmental management accessible to all.

References

[1] Climate Change Committee. The Sixth Carbon Budget The UK's path to Net Zero. December 2020. https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf

[2] Climate Change Committee (2020). Reducing UK emissions: 2020 progress report to parliament, June 2020. Available: www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/

[3] HM Government (2021). Net Zero Strategy: Build Back Greener. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1028157/net-zero-strategy.pdf

[4] https://ec.europa.eu/commission/presscorner/detail/en/statement_21_5766

[5] https://ieep.eu/news/climate-change-and-energy/agriculture-left-out-of-the-global-methane-pledge-at-cop26

[6] https://www.nfus.org.uk/news/blog/nfu-scotland-comment-on-cop26-methane-reduction-target

[7] HM Government (2021). Net Zero Strategy: Build Back Greener. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1028157/net-zero-strategy.pdf

[8] Defra, (2019). Clean Air Strategy 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf

[9] HM Government (2021). Net Zero Strategy: Build Back Greener. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1028157/net-zero-strategy.pdf

[10] Soil management: https://deframedia.blog.gov.uk/2021/09/09/soil-health-action-plan-to-be-launched/

[11] Net Zero Wales Carbon Budget 2 (2021-2025): Summary document (gov.wales): https://gov.wales/sites/default/files/publications/2021-10/net-zero-wales-summary-document.pdf

[12] https://gov.wales/sites/default/files/consultations/2021-09/agriculture-wales-bill-our-response-forward-plan.pdf

[13] Net Zero Wales Carbon Budget 2 (2021-2025): Summary document (gov.wales): https://gov.wales/sites/default/files/publications/2021-10/net-zero-wales-summary-document.pdf

[14] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf

[15] Scotland plans to set its own contribution to UK targets. https://www.gov.scot/

[16] https://www.daera-ni.gov.uk/articles/ammonia-emissions-northern-ireland

[17] This is the National Emissions Ceiling Directive (NECD) target which all UK countries are committed to. https://naei.beis.gov.uk/about/why-we-estimate?view=necd

[18] https://ec.europa.eu/commission/presscorner/detail/en/statement_21_5766

[19] As per the UK Environment Act (Part 6 on nature and biodiversity applies to England only).

[20] https://www.gov.uk/government/news/pm-commits-to-protect-30-of-uk-land-in-boost-for-biodiversity

[21] https://www.gov.scot/publications/fairer-greener-scotland-programme-government-2021-22/pages/6/

[22] https://data.jncc.gov.uk/data/6de7bf27-055e-4407-ad29-4814e1613d90/nature-positive-2030-summary-report.pdf

[23] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1010786/england-peat-action-plan.pdf

[24] https://www.gov.scot/news/funding-to-restore-scotlands-iconic-peatlands/

[25] Natural Resources Wales / The National Peatland Action Programme

[26] https://www.gardenorganic.org.uk/news/northern-ireland-peatland-strategy-2021-2040-released

[27] https://www.iucn-uk-peatlandprogramme.org/uk-strategy

[28] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (legislation.gov.uk)

[29] River Basin Management Plans which will set new targets are currently being consulted on. See https://www.gov.uk/government/publications/summary-of-the-draft-river-basin-management-plans/summary-of-the-draft-river-basin-management-plans

[30] https://www.gov.scot/policies/water/water-environment/

[31] https://www.daera-ni.gov.uk/sites/default/files/consultations/daera/Draft%203rd%20cycle%20River%20Basin%20Management%20Plan%20for%20Northern%20Ireland%202021-2027_0.PDF

[32] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/987432/england-trees-action-plan.pdf

[33] https://forestry.gov.scot/news-releases/positive-progress-on-tree-planting

[34] Written Statement: Trees and Timber (12 July 2021) | GOV.WALES. https://gov.wales/written-statement-trees-and-timber

[35] https://www.daera-ni.gov.uk/news/forest-our-future-forest-expansion-scheme-reopens

[36] https://www.gov.uk/government/speeches/environment-secretary-speech-at-delamere-forest-on-restoring-nature-and-building-back-greener

[37] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/765914/resources-waste-strategy-dec-2018.pdf

[38] https://www.gov.scot/publications/food-waste-reduction-action-plan/

[39] https://gov.wales/sites/default/files/publications/2021-10/net-zero-wales-carbon-budget-2-2021-25.pdf

[40] https://consultations2.nidirect.gov.uk/daera/food-at-the-heart-of-our-society-a-prospectus/supporting_documents/21.22.076%20NI%20Food%20Strategy%20Framework%20Consultation.PDF

[41] https://www.fao.org/sustainable-development-goals/indicators/1231/en/

[42] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/928397/structure-landuse-june20-eng-22oct20.pdf

[43] Defra (2021) Agriculture in the United Kingdom 2020. https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020

[44] https://www.cielivestock.co.uk/wp-content/uploads/2020/09/CIEL-Net-Zero-Carbon-UK-Livestock_2020_Interactive.pdf

[45] Defra (2021) Agriculture in the United Kingdom 2020. https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020

[46] Defra (2021) Agriculture in the United Kingdom 2020. https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020

[47] https://www.theccc.org.uk/wp-content/uploads/2020/01/Land-use-Policies-for-a-Net-Zero-UK.pdf

[48] https://www.environment.gov.scot/our-environment/state-of-the-environment/ecosystem-health-indicators/condition-indicators/indicator-4-farming-and-nature/

[49] https://www.thersa.org/globalassets/pdfs/reports/rsa-ffcc-northern-ireland---lay-of-the-land-final_september19.pdf

[50] UK figures taken from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1034693/AUK-2020-19nov21.pdf

[51] Unless otherwise specified England figures taken from https://www.gov.uk/government/statistics/farming-statistics-crop-areas-and-cattle-sheep-and-pig-populations-as-at-1-june-2021-england or https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/972103/regionalstatistics_overview_23mar21.pdf

[52] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/868945/structure-jun19-eng-28feb20.pdf

[53] Unless otherwise specified Scotland figures taken from https://www.gov.scot/binaries/content/documents/govscot/publications/statistics/2021/10/results-scottish-agricultural-census-june-2021/documents/agricultural-census-june-2021-tables/agricultural-census-june-2021-tables/govscot%3Adocument/agricultural-census-june-2021-tables.xlsx

[54] https://www.gov.scot/publications/results-june-2018-scottish-agricultural-census/pages/2/

[55] Unless otherwise specified Wales figures taken from https://statswales.gov.wales/Catalogue/Agriculture/Agricultural-Survey/Annual-Survey-Results

[56] Securing Wales' Future Summary (gov.wales). https://gov.wales/sites/default/files/publications/2021-03/agriculture-in-wales-evidence.pdf

[57] Unless otherwise specified Northern Ireland figures taken from https://www.daera-ni.gov.uk/sites/default/files/publications/daera/Published%20Tables%202020.ods

[58] https://www.thersa.org/globalassets/pdfs/reports/rsa-ffcc-northern-ireland---lay-of-the-land-final_september19.pdf

[59] Climate Change Committee (2020). Reducing UK emissions: 2020 progress report to parliament, June 2020. Available: https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/

[60] Defra (2021) Agriculture in the United Kingdom 2020. https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020

[61] WWF-UK, 2020. Carbon Footprint: Exploring the UK's contribution to climate change.

[62] Climate Change Committee. The Sixth Carbon Budget The UK's path to Net Zero. December 2020. https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf

[63] https://gov.wales/sites/default/files/publications/2019-06/agriculture-sector-emission-pathway-factsheet.pdf

[64] https://www.theccc.org.uk/wp-content/uploads/2019/02/Reducing-emissions-in-Northern-Ireland-CCC.pdf

[65] https://www.gov.scot/policies/agriculture-and-the-environment/

[66] https://www.theccc.org.uk/publication/land-use-policies-for-a-net-zero-uk/

[67] IDDRI Study. An agroecological Europe in 2050: multifunctional agriculture for healthy eating Findings from the Ten Years For Agroecology (TYFA) modelling exercise (2018) https://www.soilassociation.org/media/18074/iddri-study-tyfa.pdf

[68] Defra (2021) Agriculture in the United Kingdom 2020. https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020

[69] Defra (2018) The Future Farming and Environment Evidence Compendium. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/683972/future-farming-environment-evidence.pdf

[70] Soil Association (2020) Fixing Nitrogen: the challenge for climate, nature and health. https://www.soilassociation.org/media/21286/fixing_nitrogen_soil_association_report.pdf

[71] Defra (2021) Agriculture in the United Kingdom 2020. https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020

[72] Defra (2021) Agriculture in the United Kingdom 2020. https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020

[73] Defra (2021) Agriculture in the United Kingdom 2020. https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2020

[74] Soil Association (2018) To plough or not to plough. Tillage and carbon sequestration. https://www.soilassociation.org/media/17472/to-plough-or-not-to-plough-policy-briefing.pdf

[75] Committee on Climate Change (2020). Reducing UK emissions: 2020 progress report to parliament, June 2020. Available: https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/

[76] CIEL (2021) Net Zero Carbon & UK Livestock. https://www.cielivestock.co.uk/wp-content/uploads/2021/05/CIEL-Net-Zero-Carbon-UK-Livestock-FINAL-interactive-revised-May-2021.pdf

[77] CIEL (2021) Net Zero Carbon & UK Livestock. https://www.cielivestock.co.uk/wp-content/uploads/2021/05/CIEL-Net-Zero-Carbon-UK-Livestock-FINAL-interactive-revised-May-2021.pdf

[78] National Food Strategy (2021) The Evidence. https://www.nationalfoodstrategy.org/wp-content/uploads/2021/08/NFS_Evidence-Pack.pdf

[79] Forest Research (2021). Woodland statistics. https://www.forestresearch.gov.uk/tools-and-resources/statistics/statistics-by-topic/woodland-statistics/

[80] https://www.frontiersin.org/articles/10.3389/fsufs.2020.534187/full

[81] https://www.dal.ca/faculty/agriculture/oacc/en-home/resources/pest-management/weed-management/organic-weed-mgmt-resources/weeds-livestock.html

[82] There is also a need for people to change behaviour by moving towards more climate- friendly diets and reducing food waste. Behaviour change is not the subject of this report as it is geared towards actions farmers can take. For more info on that, see for example the National Food Strategy & Climate Change Committee 6th Carbon Budget.

[83] Future changes to high impact weather in the UK *(Hanlon et al, 2021)*

[84] Welsh Government/ ADAS (2020) The effect of Climate Change on Agricultural Land Classification (ALC) in Wales

[85] IBERS 2020 Climate change could wreck traditional sheep farming in Wales

[86] UK Committee on Climate Change 2017

[87] Farming Connect Technical Document: The impact of climate change on grass-based agricultural systems

[88] Natural History Museum. Biodiversity Intactness Index. https://www.rspb.org.uk/globalassets/downloads/about-us/48398rspb-biodivesity-intactness-index-summary-report-v4.pdf

[89] State of Nature (2019). https://nbn.org.uk/wp-content/uploads/2019/09/State-of-Nature-2019-UK-full-report.pdf

[90] https://data.jncc.gov.uk/data/6de7bf27-055e-4407-ad29-4814e1613d90/nature-positive-2030-summary-report.pdf

[91] British Ecological Society (2021) Nature-Based Solutions for Climate Change in the UK. https://www.britishecologicalsociety.org//wp-content/uploads/2021/05/NbS-Report-Final-Designed.pdf

[92] https://www.iucn-uk-peatlandprogramme.org/uk-strategy

[93] https://www.cpre.org.uk/about-us/cpre-media/net-zero-for-land-virtually-impossible-without-more-ambition-on-peatlands/

[94] British Ecological Society (2021) Nature-Based Solutions for Climate Change in the UK. https://www.britishecologicalsociety.org//wp-content/uploads/2021/05/NbS-Report-Final-Designed.pdf

[95] Woodland Trust. Agroforestry benefits nature, climate and farming. https://www.woodlandtrust.org.uk/plant-trees/agroforestry-benefits/

[96] British Ecological Society (2021) Nature-Based Solutions for Climate Change in the UK. https://www.britishecologicalsociety.org//wp-content/uploads/2021/05/NbS-Report-Final-Designed.pdf

[97] British Ecological Society (2021) Nature-Based Solutions for Climate Change in the UK. https://www.britishecologicalsociety.org//wp-content/uploads/2021/05/NbS-Report-Final-Designed.pdf

[98] CPRE & Organic Research Centre (2021) Hedge fund: investing in hedgerows for climate, nature and the economy. Executive summary and recommendations. https://www.cpre.org.uk/wp-content/uploads/2021/09/Hedge-fund-report-executive-summary.pdf

[99] https://onlinelibrary.wiley.com/doi/abs/10.1079/SUM2005351

[100] British Ecological Society (2021) Nature-Based Solutions for Climate Change in the UK. https://www.britishecologicalsociety.org//wp-content/uploads/2021/05/NbS-Report-Final-Designed.pdf

[101] SRUC for the Climate Change Committee (2020) Non-CO2 abatement in the UK agricultural sector by 2050 (Scottish Rural College). https://www.theccc.org.uk/publication/non-co2-abatement-in-the-uk-agricultural-sector-by-2050-scottish-rural-college/

[102] https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf

[103] Committee on Climate Change (2020). Reducing UK emissions: 2020 progress report to parliament, June 2020. Available: https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/

[104] https://www.nffn.org.uk/wp-content/uploads/2020/11/Bioenergy-Crops-final-Nov-2020.pdf

[105] Smart Protein, *Plant-based foods in Europe* (September 2020)

[106] Nature Friendly Farming Network (2021) Rethink Farming: A practical guide for farming, nature and climate. https://www.nffn.org.uk/wp-content/uploads/2021/10/NFFN-Rethink-Farming-Report_Digital-Initial-Release.pdf

[107] Environment glossary - The Prince's Countryside Fund (princescountrysidefund.org.uk)

[108] Defra & National Statistics (June 2021) Greenhouse gas mitigation practices – Farm Practices Survey England 2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/996163/fps-ghg2021-statsnotice-24jun21.pdf

[109] Defra & National Statistics (June 2021) Greenhouse gas mitigation practices – Farm Practices Survey England 2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/996163/fps-ghg2021-statsnotice-24jun21.pdf

Nature Friendly Farming Network

www.nffn.org.uk

@NFFNUK

Report funder

European Climate Foundation

Report and research

Ellie Brodie Consultancy