Department
for Environment,
Food & Rural Affairs

# Land Use Consultation

## Analytical Annex

January 2025

We are responsible for improving and protecting the environment. We aim to grow a green economy and sustain thriving rural communities. We also support our world-leading food, farming and fishing industries.

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## Contents

# Introduction

This analytical annex lays out the evidence underpinning the Land Use Consultation for England. It focuses on findings that relate to the type, scale and spatial patterns of land use change implied by Government's statutory targets to halt biodiversity decline, improve environmental quality and mitigate climate change. It places this change in the context of current land uses, sustainable and resilient food production, and social, economic and cultural drivers of land use change.

Improving the state of the environment and mitigating climate change involves planting trees, restoring peat, and creating or restoring a wide range of wildlife-rich habitats. We have assessed how much land use change comes with meeting Government's statutory targets and commitments: section 2 explains the assumptions we have made and section 3 presents our findings on the overall scale of change.

The potential of land to support different land uses and corresponding outcomes varies considerably across England. This means that the overall national scale of change does not imply a uniform transition across the country. This is why we have taken a spatial approach to our analysis and have explored what the land use transition could mean geographically. Our spatial analysis in section 4 shows how the scale of change implied by environmental and climate commitments varies across England. We have assessed the potential impacts on food production and provided insights into the many ways in which food production and environmental land uses can co-exist. Our spatial analysis underpins the proposed spatial principles in the Land Use Consultation.

We have taken a systems approach to understand how social, economic and cultural drivers of land use change interact (section 5). Using desk-based research, a survey, and place-based workshops, we have gathered and analysed evidence on what drives land use decisions on the ground. This has underpinned the proposed policy levers and enablers in the Land Use Consultation.

The findings reported in this document have been produced by Defra's Land Use Analysis and Research Programme. The programme is transdisciplinary and integrates spatial modelling, systems analysis, place-based research and socio-economic analysis. It is part of the ecosystem of land use research and analysis programmes in the UK. This analysis has been informed by a range of wider publications from, or by collaboration with, organisations including the Royal Society, University of Leicester, the LEEP Institute at University of Exeter, the UK Centre for Ecology and Hydrology, the RSPB, and the Food Farming and Countryside Commission (FFCC). Research programmes such as the Land Use for Net Zero, Nature & People Hub and Strategic Research reflect our investment in collective land use expertise, drawing together academics, policymakers, and other stakeholders to provide the breadth of evidence needed to design and deliver effective policy that impacts on land use.

# 1 Land Use in England today

## 1.1 England is a predominantly rural and agricultural country

England is made up of a mosaic of different land uses, with two thirds of its area (67%) being agricultural[1] while built-up areas take up 11% of land[2]. The following paragraphs provide a picture of current land uses in England[3].

**Agricultural land uses are balanced between arable and grassland**

Arable land represents 38% of England's land and is mainly used to produce crops for food and animal feed[1]. Grassland represents 29% of England's land and is primarily used for animal grazing[1]. Less than 1% of land is used for horticulture, largely growing fruits and vegetables.

There are significant regional variations in the type and quality of England's agricultural and rural land. For example, much of the most productive arable farmland can be found in the east of England, where the land is largely flat and the summers are generally dry. The southwest, with gentle hills and a wetter climate, is home to around 40% of England's dairy herd[4]. Hillier upland areas across the country (including along the Pennines), tend to consist of lower quality farmland and predominantly feature sheep farming.

**England's rural landscapes include woodland, peatland and other habitats alongside farmland, but they are not in good condition**

England has a variety of woodlands, from productive conifer stands to temperate rainforests. Woodlands cover 10.2% of England, with trees outside woodlands, including orchards,

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[1] This is the official statistic for Agricultural Area (UAA) in England: UAA is made up of all arable and horticultural crops, uncropped arable land, land used for outdoor pigs, temporary and permanent grassland and common rough grazing https://www.gov.uk/government/statistics/agricultural-land-use-in-england/agricultural-land-use-in-england-at-1-june-2024

[2] See Office for National Statistics for characteristics of built-up areas: https://www.ons.gov.uk/peoplepopulationandcommunity/housing/articles/townsandcitiescharacteristicsofbuiltupareasenglandandwales/census2021#built-up-areas

[3] The percentages provided in the following paragraphs are not intended to sum up to 100% as figures have been rounded and there is overlap between some categories.

[4]Agriculture in the UK Evidence Pack, September 2022 update https://assets.publishing.service.gov.uk/media/6331b071e90e0711d5d595df/AUK_Evidence_Pack_2021_Sept22.pdf

covering an additional 4.7%[5]. 92% of native woodland is in intermediate condition[6], but just 9% is in favourable condition.

Peatland covers 11% of England. However, 87% of England's peatlands are now degraded, damaged and dried out, emitting the equivalent of ~8 Megatons (Mt) of $CO_2$ into the atmosphere each year[7].

England has a variety of habitats that support biodiversity. Some areas of England support many characteristic, rare and endangered species, habitats and natural features: these are often designated as Sites of Special Scientific Interest (SSSI)[8]. Only 38% of SSSIs were in favourable condition in 2023 (unchanged since 2016), with 49% in unfavourable recovering condition (a decrease from 57% in 2016)[9].

Inland water bodies in England cover 1% of land (150kha), which includes rivers, canals, lakes and reservoirs[10]. They are critical in supporting other land uses. However, currently only 16% of surface waters[11] assessed achieve good ecological status. Additionally, although 73% of groundwater (water stored below the water table, for example in rocks) is rated as "good" in terms of quantity, only 45% is rated "good" in terms of quality[12].

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[5] Forestry Statistics 2024, Chapter 1: Woodland Area & Planting: https://cdn.forestresearch.gov.uk/2024/10/Ch1_Woodland-WA-amendment.pdf

[6] The principal reasons for woodlands being classed as intermediate condition are lack of veteran trees and deadwood, limited open space within woodland and high levels of deer browsing. Sustainable woodland management of native woodlands is a key action to improve condition, but this will take time as woodlands respond slowly to intervention.

[7] UK Greenhouse Gas Inventory, 1990 to 2022: Annual Report for submission under the Framework Convention on Climate Change https://naei.energysecurity.gov.uk/reports/uk-greenhouse-gas-inventory-1990-2022-annual-report-submission-under-framework-convention

[8] Sites of Special Scientific Interest (England) | Natural England Open Data Geoportal https://naturalengland-defra.opendata.arcgis.com/datasets/Defra::sites-of-special-scientific-interest-england/about

[9] Accredited official statistics: Extent and condition of protected areas (2024) https://www.gov.uk/government/statistics/england-biodiversity-indicators/1-extent-and-condition-of-protected-areas--2

[10] Official Statistics: Land use in England, 2022 https://www.gov.uk/government/statistics/land-use-in-england-2022.

[11] This category includes estuaries and coastal waters in addition to the inland water bodies listed above.

[12] State of the water environment indicator B3: supporting evidence (2025) https://www.gov.uk/government/publications/state-of-the-water-environment-indicator-b3-supporting-evidence/state-of-the-water-environment-indicator-b3-supporting-evidence

**Towns and cities do not cover a lot of land, but contain most of England's population**

By population, England is largely urban: 83% of people lived in urban areas (settlements of more than 10,000 inhabitants) in 2020[13]. Urban areas made up 15% of England's land cover in 2011[14], the most recent year for which this statistic is available.

Other European nations with relatively high population density, such as Belgium and the Netherlands, have a similar or slightly larger footprint of urban land as a percentage of the total land area. In Belgium, 79.6% of people live in urban clusters[15] on 21.4% of the total land area[16]. In the Netherlands, these figures are 86.5% and 15.9% respectively.

**Key infrastructure has a limited land take**

Key transport infrastructure covers 4.2% of England's land[10]. Highways and road transport infrastructure (including roads, bus stations and public car parks) make up 88% of this land area. The rest includes other transport such as railways, airports and docklands.

The land area taken by all key utilities across England, including solar and wind farms, power stations, water works, gas works, and refuse disposal places, covers 0.2% of land[10].

## 1.2 England's natural capital delivers £37bn per year in benefits

Our natural capital (farmland, woodland, peatland, and other habitats) offers a range of benefits and is an important source of national wealth. It contributes to the economy via a range of ecosystem services, across three categories:

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[13] Statistical Digest of Rural England, April 2024: https://assets.publishing.service.gov.uk/media/661d3b95ac3dae9a53bd3dd3/16_04_2024_-_1_-_Population.pdf

[14] The 2011 Rural-Urban Classification for Output Areas in England https://assets.publishing.service.gov.uk/media/610c08e4d3bf7f044024465a/RUCOA_leaflet_Jan2017.pdf

[15] Note the difference in methodology in defining urban land between these countries and England, which limits a precise comparison: 'Urban clusters' are defined "a cluster of contiguous grid cells of 1 km² (including diagonals) with a population density of at least 300 inhabitants per km² and a minimum population of 5,000 inhabitants". (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Territorial_typologies_manual_-_cluster_types#Classes_for_the_typology_and_their_conditions ).

[16] In 2021. Source: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Urban-rural_Europe_-_introduction#Land_cover

- Provisioning services, such as food or timber production, which have a market value and directly support production in economic sectors such as farming;
- Regulating services, such as flood prevention / mitigation, carbon sequestration and air pollution removal, or regulation of urban temperature, which do not support a particular economic sector, but support the workings of the whole economy by preventing and reducing the costs of environmental hazards;
- Cultural services, such as nature-based recreation/tourism and recreation-related health benefits, which contribute to human capital value as well as supporting economic sectors.

In 2022, the ONS estimated the value of the annual flow of these services, excluding fossil fuels, to be more than £37bn, with an asset value of £1.3tn[17]. Cultural services represented more than half of this annual amount.

[17] Figures derived from UK natural capital accounts 2024
https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapitalaccounts/2024

# 2 Our land use change assumptions

## 2.1 Improving environmental outcomes and mitigating climate change implies land use change

Since the end of the Second World War, there has been a period of relative stability for land use and limited change to what society demands from land. However, this is now changing: there is increased recognition that clean water and air, rich biodiversity, climate mitigation and climate adaptation are required outcomes of land use alongside food production, infrastructure and housing.

**Environment**

To improve environmental outcomes, land-based targets were set in secondary legislation under the Environment Act 2021 (England):

- Biodiversity:
  - Restore or create more than 500,000 hectares of a range of wildlife-rich habitat outside protected sites by 2042.
  - Halt the decline in species abundance by 2030.
  - Improve species abundance so that by 2042 it is higher than in 2022 and at least 10% higher than in 2030.
  - Reduce the risk of species' extinction by 2042, when compared to the risk of species' extinction in 2022.
- Trees and woodland:
  - Increase tree canopy and woodland cover to 16.5% of total land area in England by 2050 (from the 2023 baseline).
- Water quality:
  - Reduce nitrogen, phosphorous and sediment pollution of the water environment from agricultural land by 40% by 2038 (from 2018 baseline).

The UK Government has also committed to the international target of protecting 30% of the UK's land and sea for nature by 2030 (30by30).

**Climate change mitigation**

Government has committed to meeting our statutory Carbon Budgets as part of our Clean Energy Superpower mission and the accelerating to Net Zero Pillar. Land Use, Land Use

Change and Forestry[18] (LULUCF) is one of the sectors contributing to Net Zero. It has a range of land use implications in England – see Table 1.

**Other commitments in the Environmental Improvement Plan (EIP)**

The EIP includes environmental commitments which are not statutory but have land use implications, for instance: reducing risks and impacts from floods and droughts; maintaining a sustainable and long-term supply of timber and wood products; every household being within 15 minutes' walk of green / blue space[19]. Government has launched a review of the Environmental Improvement Plan (EIP). Following this review, the Government will develop a revised EIP to protect and restore our natural environment at the scale and pace that is needed, drawing on the review's findings and a wide range of stakeholder input.

**The types of land use change implied by the Government's targets and commitments are varied across tree planting, habitat creation / restoration and peat restoration**

There is a high level of confidence in the *types* of land use changes needed to meet Government's targets and commitments on environment and climate.

**Table 1: Types of land use changes needed to meet Environment Act Targets and Net Zero contributions**

| Targets | Land use changes needed |
|---|---|
| Trees and woodland (see sub-section "Environment" for detail of target) | Tree planting, including woodland (conifer and broadleaf), agroforestry, hedgerows. |
| Biodiversity (see sub-section "Environment" for detail of targets) | Habitat creation or restoration inside and outside of protected sites[20]. Includes:<br>• Broadleaf woodland |

[18] Covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land use change and forestry activities. Carbon is sequestered by forestry and grassland, while carbon losses occur on existing cropland and natural land (for example, grassland) that is converted to cropland or settlement. (https://www.theccc.org.uk/wp-content/uploads/2013/03/LULUCF.pdf)

[19] In August 2024 Government launched an official statistic in development for the 15 Minute Commitment (Access to Green Space). Further detail available at: https://www.gov.uk/government/statistics/access-to-green-space-in-england/access-to-green-space-in-england

[20] Further detail on creation and restoration that can count towards the habitat target is available at: https://publications.naturalengland.org.uk/publication/6427187599900672

| | |
|---|---|
| | • Plantations in ancient woodlands and other woodland habitats<br>• Grassland habitats including associated scrub<br>• Coastal and heathland habitats including associated scrub<br>• Arable field margins<br>• Peat dependent habitats & other wetlands<br>• Coastal & transitional waters |
| LULUCF contributions for Carbon Budgets 4-6 and estimated contributions to 2050 | • Tree planting: woodland, hedgerows, silvopastoral systems[21]<br>• Agroforestry: silvoarable systems[21]<br>• Woody biomass: short rotation coppice (SRC), short rotation forestry (SRF), and miscanthus<br>• Restoration and maintenance of peat-forming and peat-dependent habitats (including wetlands and upland heath)<br>• Responsible management of lowland peat |
| Water quality (see sub-section "Environment" for detail of target) | Any land use change listed above supports the target, but it matters where the land use change takes place. This is because the pressures that land use change tries to mitigate tend to be localised in specific types of places. |
| Other EIP commitments, such as reducing risks and impacts from floods and droughts | |

We also have a high level of confidence that some land use changes contribute to more than one target or commitment, as seen in Table 1. For instance, the creation of broadleaf woodland habitats outside of protected sites will count towards the Environment Act trees

[21] In a 'silvoarable' farming system trees and arable crops occupy the same parcel of land, i.e. cereal crops are produced in a field in containing trees, which may also produce a harvestable crop such as nuts or fruit. A 'silvopastoral' farming system involves livestock and trees occupying the same parcel of land, i.e. grazing livestock in a field containing trees. These systems are considered separately in the context of contributions to carbon budgets as it is assumed that silvoarable systems involve a higher number of trees per hectare than silvopastoral systems, with the former resembling the tree density of a commercial orchard.

target and 30by30, but will also contribute towards the Environment Act biodiversity targets and Net Zero contributions, and possibly others depending on the location.

**We have varying levels of confidence about the amount of land use change needed for each target or commitment**

1. Some Environment Act Targets are *area-based*, making explicit the scale of change needed. They are:

- Increase tree and woodland cover to 16.5% of total land area in England by 2050 (from a 2023 baseline);
- Restore or create more than 500,000 hectares of wildlife-rich habitat outside protected sites by 2042.

These targets do not, however, prescribe the mix of tree species, density, or habitat types to be created or restored. We need to make assumptions about these (see Table 2 below).

The 30by30 target is also area-based and we are determining how much additional land is needed to contribute to this target. We have developed three criteria that land needs to meet to contribute towards 30by30 in England; Purpose, Protection and Management[22]. We have identified that 11% of England is likely to already be meeting one of the three criteria. Further analysis is being undertaken to better understand how much land is already meeting 30by30 criteria or has the potential to do so.

2. Other land-based Targets are *outcome-based*. Modelling is required to estimate how much land would be needed to meet them, above and beyond the tree planting and habitat creation / restoration needed for area-based targets. Outcomes will depend on a number of factors beyond the *amount* of land use change, such as habitat connectivity and quality. Modelling is under development to explore this further, for example on understanding the impacts of land use change on species abundance targets. The outcome-based targets are:

- Halt the decline in species abundance by 2030.
- Improve species abundance so that by 2042 it is higher than in 2022 and at least 10% higher than in 2030.
- Reduce the risk of species' extinction by 2042, when compared to the risk of species' extinction in 2022
- Reduce nitrogen, phosphorous and sediment pollution of the water environment from agricultural land by 40% by 2038 (from 2018 baseline).

We are currently assuming that no additional land use change is needed for these targets over and above that needed for the area-based targets. We have made the same

[22] Detailed descriptions of 30by30 criteria: https://www.gov.uk/government/publications/criteria-for-30by30-on-land-in-england/30by30-on-land-in-england-confirmed-criteria-and-next-steps

assumption for non-statutory EIP commitments. These assumptions might lead to an underestimation of the overall scale of change.

3. The hectarages needed for Net Zero contributions have been estimated from the modelled emission savings for the sector, projected on an England-only basis and using illustrative scenarios. The level of uncertainty in these estimations is relatively high, however, we expect to make refinements as the modelling progresses.

**The availability and quality of evidence on land use assumptions has informed what we have included in our analysis**

Table 2 summarises how we have reflected the land take from environmental and climate targets or commitments in our analysis. This underpins our analysis of the overall scale of change as described in section 3.

**Table 2: Land use implications included in our analysis**

| Target/commitment | Type | What we include in our analysis[23] |
|---|---|---|
| Increase tree canopy and woodland cover to 16.5% of total land area in England by 2050 (from 2023 baseline) | Area-based | Target hectarage: We have used an estimate of the gross hectarage of woodland creation required to achieve a net increase in canopy cover to 16.5% of total land area by 2050, assuming a certain level of deforestation. There are uncertainties attached to the level of deforestation, which translates into some uncertainty on the estimate of gross hectarage of planting required. In addition, trees outside woodland also count towards this target, but the net contribution from these is not yet clearly understood[24].<br><br>There are assumptions on the breakdown between conifer, broadleaf, and silvopastoral systems. The breakdown is not prescriptive and we only use it as an indication. |

[23] Note that the indicative breakdowns cannot be published at this time. Different levels of aggregation are however available in section 30.

[24] The next planned round of remote sensing of canopy cover changes should further our understanding of this. We have committed to updating remote sensing at least every five years.

| | | |
|---|---|---|
| Restore or create more than 500,000 hectares of a range of wildlife-rich habitat outside protected sites by 2042. | Area-based | Target hectarage and assumptions on breakdown across habitat types. The breakdown is not prescriptive and we only use it as an indication. |
| LULUCF contributions for Carbon Budgets 4-6 and estimated contributions to 2050 | Outcome-based | Modelled hectarage for each land use change pathway: Tree planting; silvoarable systems; planting of SRC, SRF, miscanthus; restoration and maintenance of peat-forming and peat-dependent habitats[25]; responsible management of lowland peat[26].<br><br>We have accounted for overlaps with area-based targets (tree and habitats). |
| All other targets and commitments[27] | Outcome-based | We are currently assuming that no additional land use change is needed above and beyond the hectarages listed in previous rows. |

**Assumptions are updated as new evidence becomes available**

The EIP review process may generate new assumptions on the land use change implied by meeting targets and commitments set out in the Environment Act and EIP. We will update our analysis to take account of these updated assumptions as they arise.

[25] The new England Peat Map will be published in 2025. This will provide an updated assessment of the baseline area of peat in England, which may have implications for assumptions on the extent of peatland restoration.

[26] In 2025, Government will agree the Seventh Carbon Budget (CB7). During this process, assumptions on the extent of responsible management of peatland may be updated.

[27] Halt the decline in species abundance by 2030; Ensure that species abundance in 2042 is greater than in 2022, and at least 10% greater than 2030 levels; Reduce the risk of species' extinction by 2042, when compared to the risk of species' extinction in 2022; Protect 30% of UK land by 2030 in order to halt nature decline and protect and improve biodiversity; Reduce nitrogen, phosphorous and sediment pollution of the water environment from agricultural land by 40% by 2038 (from 2018 baseline); Other EIP commitments

## 2.2 Demand for land for infrastructure, housing and other development is likely to continue to grow

Government has made commitments to increase the delivery of energy infrastructure and housing. For instance, Government has committed to building 1.5 million new homes over the next parliament, which could represent around 30 thousand hectares of land take, if it were composed of the same split of new homes between new build completions, conversions and change of use as for recent years (the period 2019-2022)[28]. It is worth noting that this figure is based on applying a set of simple assumptions to statistics from previous years, so is of course subject to uncertainty. For example, any changes in the proportion of new housing that is newly built would affect the amount of land needed.

For inclusion of housing land take in our modelling, we have estimated the possible land take of urban expansion on a longer timescale, beyond that for which there are housing targets. To 2050, this totals approximately 150,000ha (from 2021). This is based on the expected growth in households to 2050 as a proportion of the existing urban land area and should be understood as an order of magnitude rather than a precise calculation. Whilst it is not directly derived from the 1.5m homes target, it is broadly consistent, taking account of the different timeframes of the figures.

We are in the process of improving our evidence base on the spatial implications of housing and infrastructure targets by collaborating with the Ministry of Housing, Communities and Local Government (MHCLG) on New Towns and other housing targets, the Department for Energy Security and Net Zero (DESNZ) on the Strategic Spatial Energy Plan, and HM Treasury on the 10-year Infrastructure Strategy.

[28] Assuming the same split of new homes between new build completions, conversions and change of use as for recent years (the period 2019-2022), 1.5 million new homes could be expected to involve about 1.33 million new build completions. Assuming the same ratio between numbers of new homes and amount of land changing use to residential (based on MHCLG statistics on housing supply and land use change (hectarage)) as for recent years (during the three years from April 2019 to March 2022), these could be expected to occupy 32,700 hectares of land (rounded to 30 thousand hectares). Sources: i) Land Use Change (hectarage) 2019-2022, Live Table P370, land changing to residential use (https://www.gov.uk/government/statistics/land-use-change-hectarage-2019-to-2022); ii) Housing supply- net additional dwellings, Table 120, new build completions and total net additions, 2019-20, 2020-21 and 2021-22 (https://www.gov.uk/government/statistical-data-sets/live-tables-on-net-supply-of-housing)

# 3 The scale of the land use transition

## 3.1 We have developed a categorisation to reflect the diversity of change

We have developed a categorisation of land use change aiming to describe the diversity of opportunities available to landowners and managers. Some changes are about delivering environmental and climate benefits alongside food production (such as agroforestry), while others are about freeing up land for environmental and climate benefits (such as woodland creation). Table 3 provides a description and examples for each category; it also specifies the resulting land uses and main resulting outcome types.

**Table 3: Categories of land use change options for landowners and managers**

| Category of land use change, with description | Resulting land use | Main resulting outcome type(s) |
|---|---|---|
| **Category 1 – Land management change**<br><br>Changes in the way the land is farmed, without introducing new habitats or planting trees. It falls outside of the scope of land use change discussed in this document, except in section 4.5. Examples include: planting cover crops to reduce soil loss, or reducing fertiliser use to prevent water pollution**.** | Agricultural land | Food production |
| **Category 2 – Small changes maintaining the same agricultural land use**<br><br>Introducing nature within fields, in margins and / or small portions, providing environmental and climate benefits alongside food production. Examples include:<br><br>• Arable field margins<br>• Riparian features such as river buffer strips<br>• Any other small changes under nature-friendly farming or species recovery actions | Agricultural land | Food production |
| **Category 3.1 – Changes in agricultural land use, for both food and environmental / climate benefits**<br><br>This is mainly about creating silvoarable or silvopastoral systems (agroforestry). | Agricultural land | Both food production and environmental / climate benefits |

| | | |
|---|---|---|
| **Category 3.2 – Changes in agricultural land use, mainly for environmental and climate benefits with limited food production**<br><br>The land is being farmed mainly for other benefits than food. Examples include:<br><br>• Creation/restoration of species-rich grassland habitats, including associated scrub<br>• Responsible management of peat<br>• Planting of miscanthus<br>• Planting of short rotation coppice (SRC) | Agricultural land | Environmental / climate benefits and non-food agricultural production |
| **Category 4 – Change away from agricultural land, for environmental and climate benefits**<br><br>Land use becomes non-agricultural. Land is fully dedicated to delivering environmental and climate benefits. Examples include:<br><br>• Restoration and maintenance of peat-forming and peat-dependent habitats (including wetlands and upland heath)<br>• Creation / restoration of coastal and lowland heathland habitats, including associated scrub<br>• Creation of woodland<br>• Planting of short rotation forestry (SRF) | Non-agricultural land | Environmental / climate benefits |

It is worth noting that only category 4 involves a complete change to non-agricultural land. Land would still be considered agricultural as an outcome of the other categories of change: it would be farmed for food production and / or environmental and climate benefits. All types of land use changes would benefit food production in the long term, because both productivity and sustainability of food production rely on ecosystem services provided by biodiversity, healthy soil and clean water.

## 3.2 Environment Act Targets and Net Zero imply at least 1.6Mha of land use change by 2050

All of the changes in land use described below need to be delivered over the next 25 years, as part of the continuation of the agricultural transition. Our estimation of the total land use change to deliver our environment and climate targets and commitments amounts to 1.6Mha by 2050, around one-fifth of Utilised Agricultural Area (UAA). We have come to this figure

by summing up assumptions of land take for targets and commitments, while accounting for overlaps where land use change counts towards more than one target. This might be an underestimation as we have currently assumed that no additional changes are needed for several outcome-based targets (see assumptions in section 2.1). These evidence gaps are being addressed through the rapid review of the EIP.

Table 4 shows how, according to our analysis, this total is broken down across the land use change categories. Roughly half is change away from agricultural land, while the other half represents changes in how agricultural land is used.

**Table 4: Scale of change to meet Environment Act and climate change targets in line with current assumptions, broken down according to our land use change categories.**

| Category of change | Estimated amount to 2050 across Environment Act Targets and Net Zero (current assumptions, rounded figures[29]) |
|---|---|
| Category 2 - Small changes maintaining the same agricultural land use | 50 kha. c.1% of utilised agricultural area |
| Category 3.1 - Changes in agricultural land use, for both food and environmental / climate benefits | 370 kha. c.4% of utilised agricultural area |
| Category 3.2 - Changes in agricultural land use, mainly for environmental and climate benefits with limited food production | 430 kha. c.5% of utilised agricultural area |
| Category 4 - Change away from agricultural land, for environmental and climate benefits | 760kha. c.9% of utilised agricultural area |

The targets have different timelines, the furthest into the future being 2050 for Net Zero and the trees target. We use assumptions of yearly delivery profiles to estimate the associated scale of land use change to 2035. This allows an understanding of the temporal aspect of change. We have found that around half of the total change required to meet our environmental targets and commitments needs to happen by 2035 (Figure 1).

[29] The sum amounts to c.18% of UAA, rounded to c.20% in the text above.

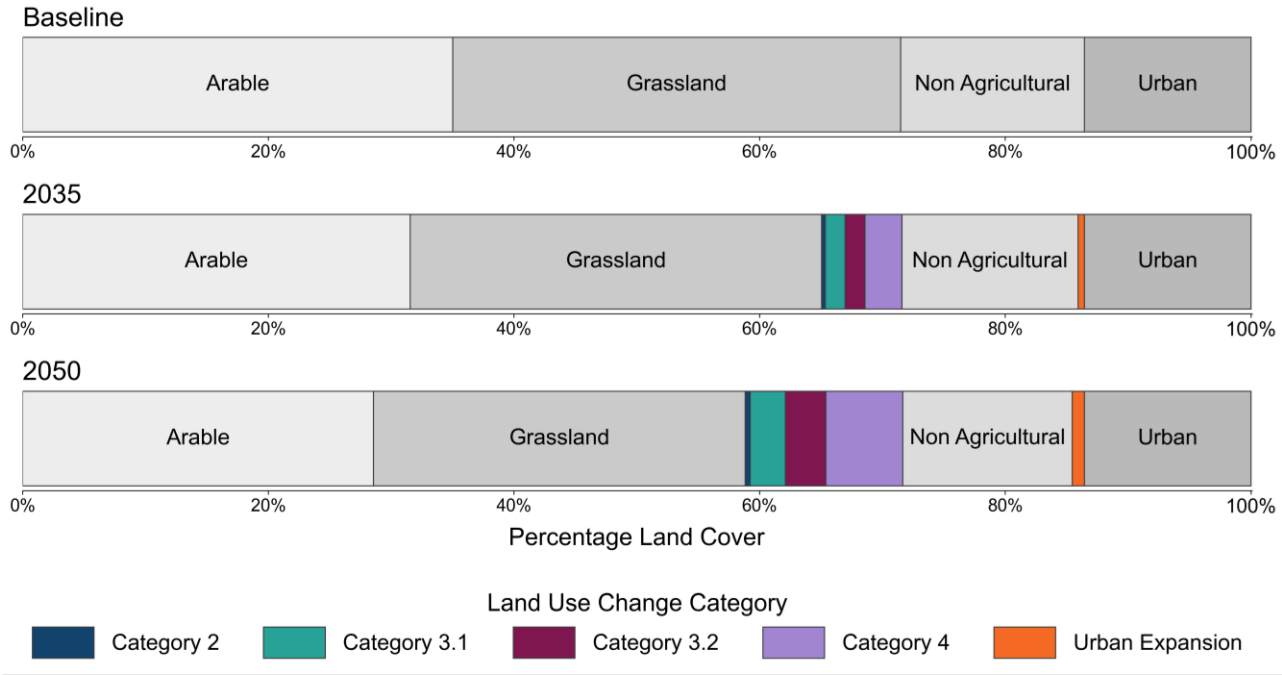


**Figure 1: Indicative type and extent of land use changes to improve environmental and climate outcomes to 2035 and 2050. This is in line with current assumptions of land take to meet Environment Act and climate change targets[30]**

[30] Note that the baseline differs slightly from the official statistics reported in section 1. This is because we used the UKCEH Land Cover dataset to produce this figure. We are using this dataset to perform the spatial analysis reported in later sections, because official statistics are not spatially-explicit. This is why we decided to use this data for the baseline to ensure consistency. The differences with official statistics are due to the difference in data sources used and are in the range of a few percentage points.

# 4 A spatial understanding of the land use transition

Land use change will not be uniform across the country. The potential of land to support different land uses and corresponding outcomes varies considerably across England. This is why we have taken a spatial approach to our analysis and have explored what the land use transition could mean geographically. This section lays out findings from our spatial analysis.

**Methodological Box 1: Approach taken to the spatial modelling**

Defra developed a spatial model to help consider the implications of simultaneously achieving environmental and climate targets and commitments by 2050 on land in different parts of the country. The model simulates changes in land use to achieve national aims and then examines what this typically means in terms of the amount and type of land use change that results in different landscapes. The simulated reallocation of land use is guided by consideration of the biophysical suitability of a unit of land to support different alternative uses such as food production, as well as any pre-existing constraints on the land use change such as those from environmental and planning protections. A random element is introduced to the reallocation during a simulation, reflecting the uncertainty about where change might occur.

Different scenarios have been run that integrate economic and climatic factors and reprioritise amongst policy choices. The results of this modelling can be compared in terms of their impacts on outcomes such as nutrient pollution and biodiversity. The approach taken means that the model does not optimise or prescribe where land use change should occur. It suggests where change might happen given how the suitability for different types of land use change varies spatially.

## 4.1 The potential of land to support different uses varies across the country

**Tree planting**

Figure 2 shows how broadleaf tree growth potential varies across England. It is important to note that tree growth potential, and the capacity for carbon storage, is only one possible outcome that we may want to achieve when changing land use. Trees are planted for different purposes and good growth can be achieved on a range of sites through careful species selection. Other ecological sensitivities will also need to be considered in making choices about land use changes, that may mean that tree planting is not appropriate on a given site, for example on deep peat.

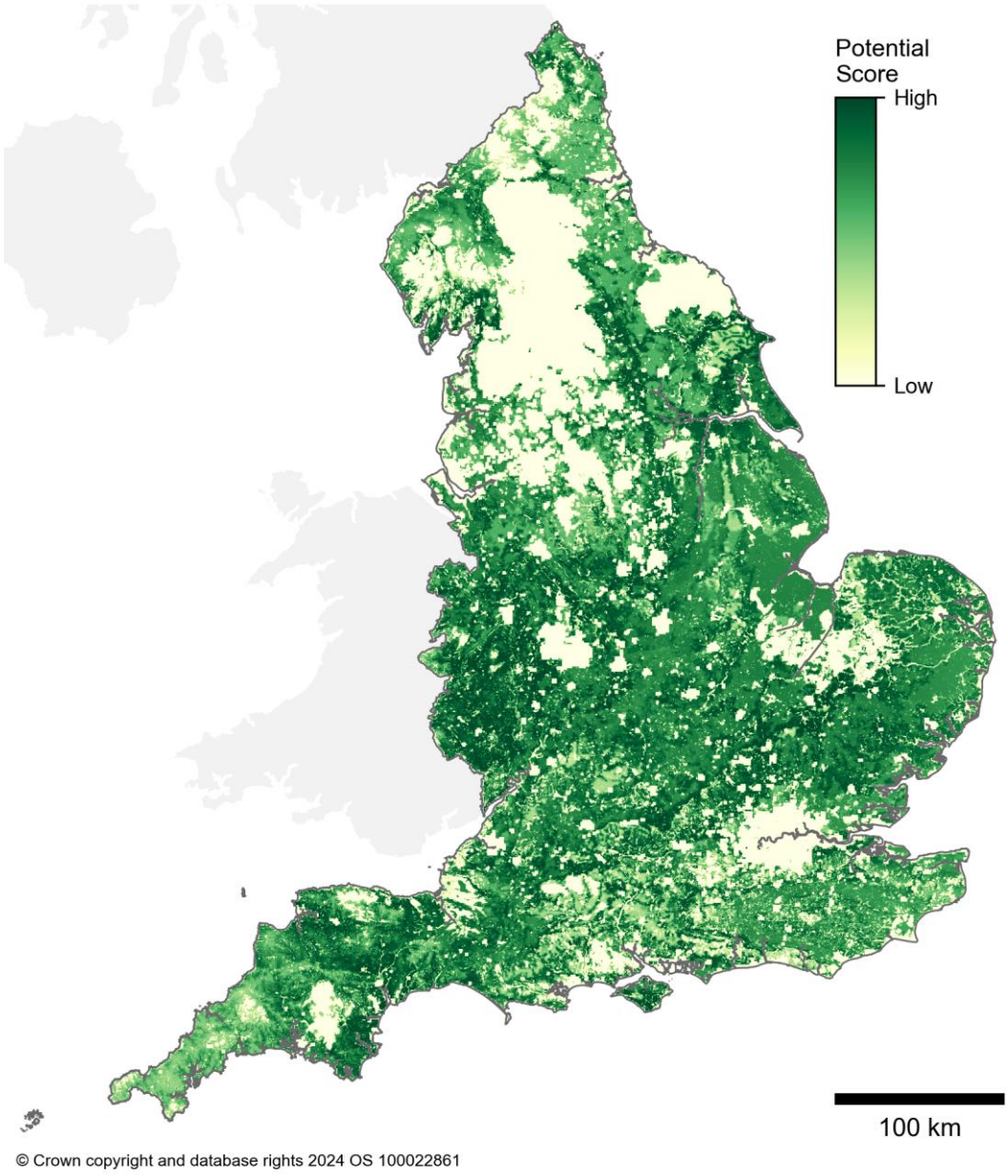


**Figure 2: Map showing the relative potential for Broadleaf tree growth across England in 2050. High potential is defined by how well the environmental context enables broadleaf tree growth (including soil conditions, climate patterns). Highly suitable locations exhibit high modelled potential growth rates under present day climate conditions (see Figure 6 for modelled growth potential under climate change scenarios). Growth potential data is derived from Forest Research's Ecological Site Classification tool[31].**

[31] Forest Research's Ecological Site Classification tool, accessible here: https://www.forestresearch.gov.uk/tools-and-resources/fthr/ecological-site-classification/

**Habitat creation / restoration**

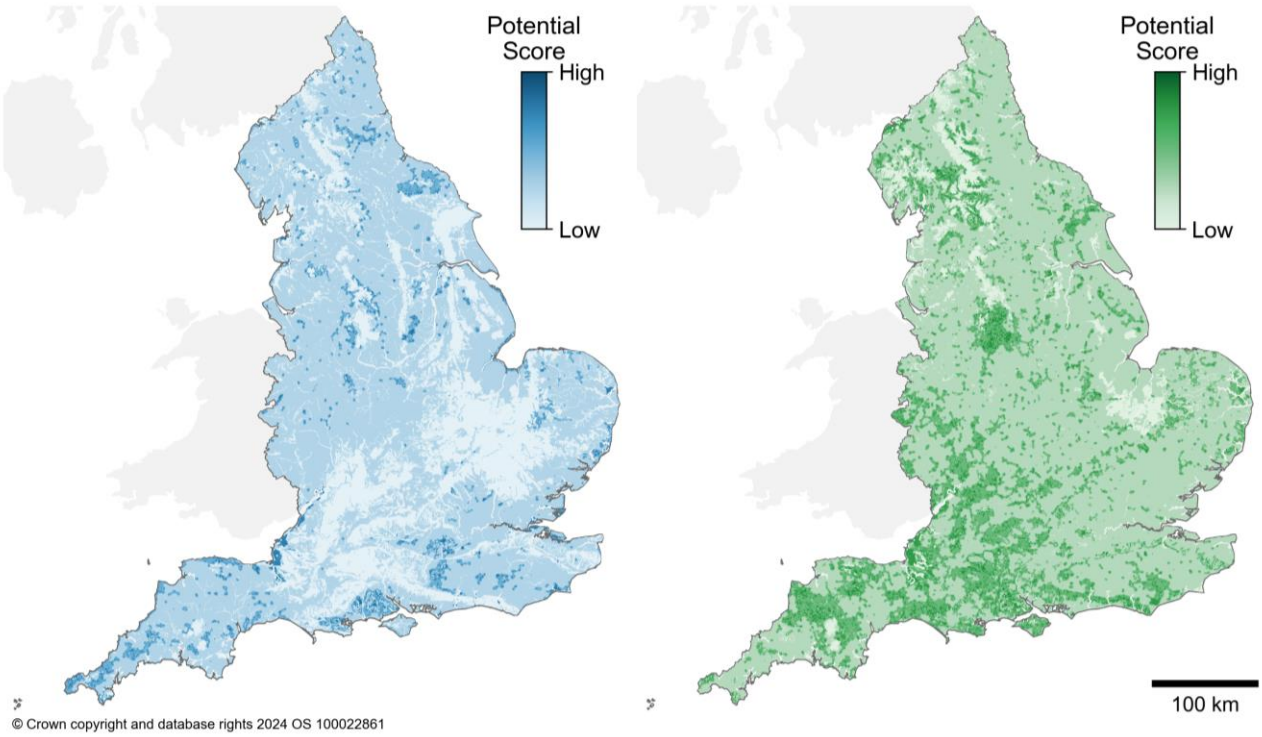


Figure 3 illustrates how habitat potential varies across England for coastal / heathland (left-hand map) and grassland (right-hand map). In both cases, the amount of highly suitable locations is a much smaller proportion than broadleaf tree potential.

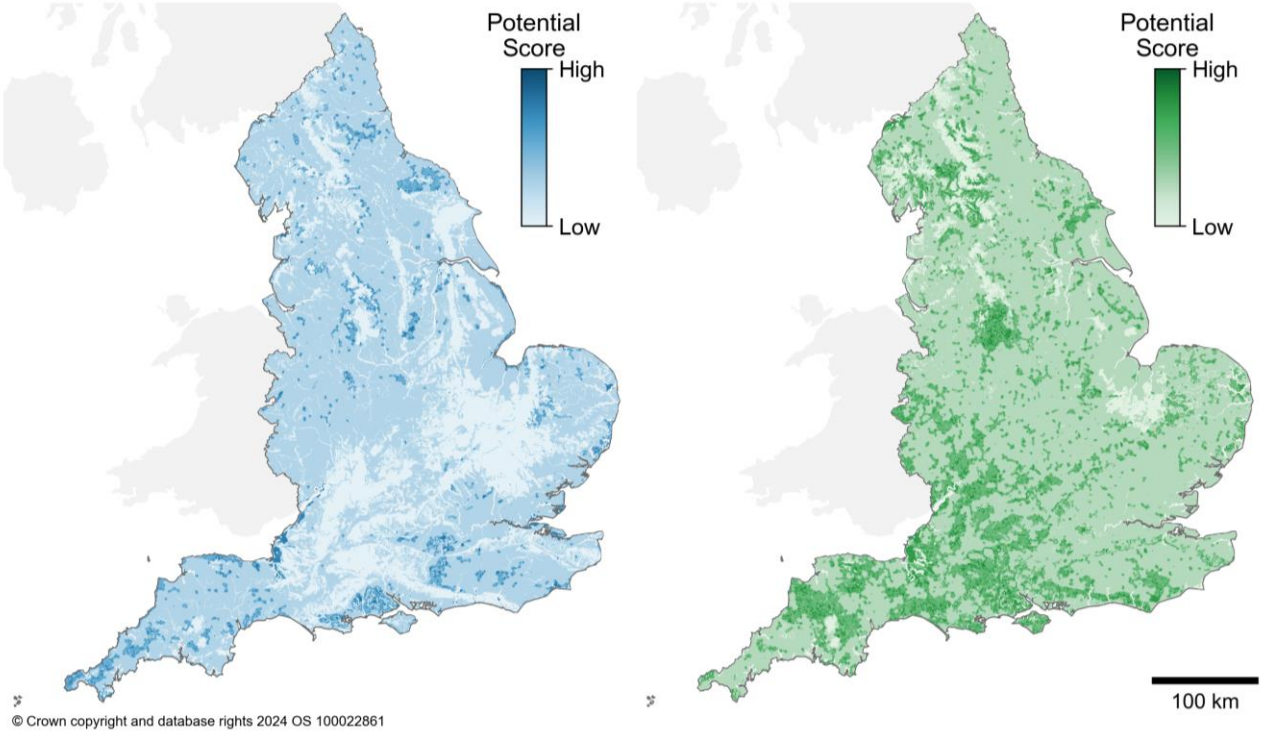

**Figure 3: Left: Map showing the relative potential of land-based coastal and heathland habitats across England. Right: Map showing the relative potential of land grassland habitats across England. Maps are derived from Natural England's Habitat Network Maps[32] and Soilscapes data[33].**

Whilst some habitats are widespread, and able to be created in a wide range of conditions (for example, planting native woodlands), others are more sensitive to location, and require specific hydrological or soil conditions to establish. This spatial sensitivity of habitats can be measured as their potential 'opportunity size'. Figure 4 shows that all habitats have a relatively limited opportunity size, at most 14% of England. However, some have a much more limited opportunity space than others. For instance, the opportunity space for Lowland Raised Bogs represents less than 1% of England.

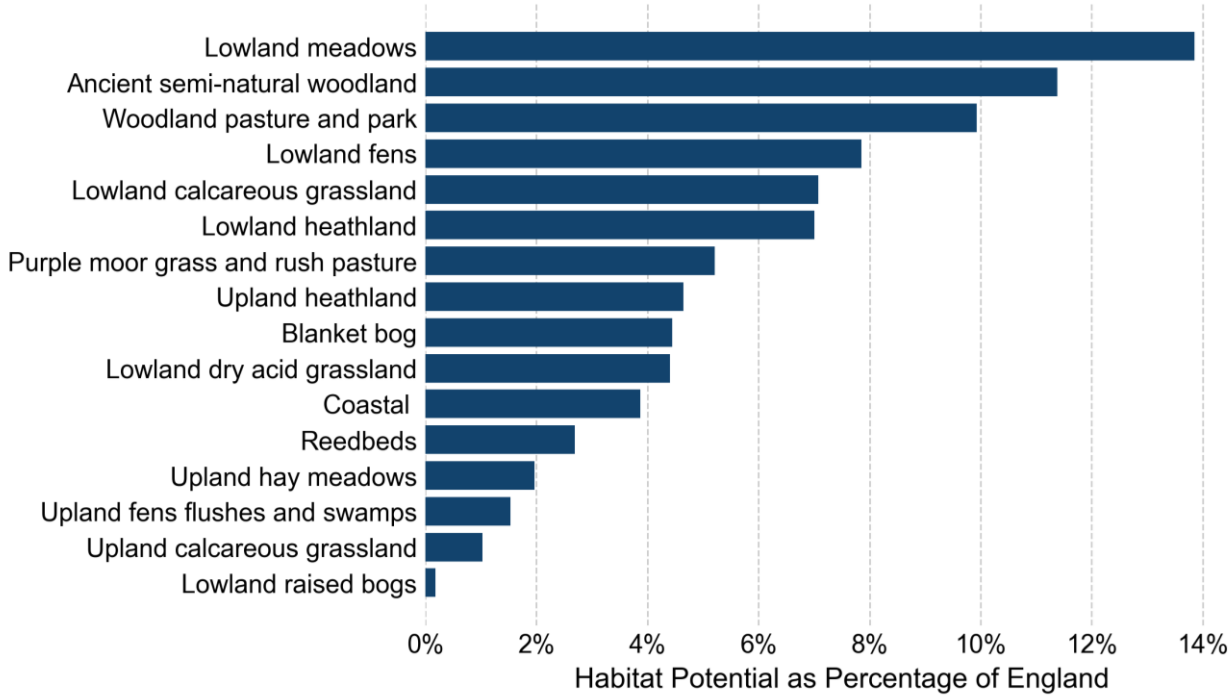


**Figure 4: Maximum potential size of priority habitat types, as a proportion of the total area of England, data derived from the Habitat Network Maps[34]. These figures depict the maximum area of land that could be suitable for these habitats and are not intended scales for delivery of targets.**

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[32] Natural England's Habitat Networks, accessible here: https://environment.data.gov.uk/dataset/5e614b67-ccd0-4673-8ad8-adddf538125e

[33] Cranfield University Soilscapes data, accessible here: https://www.data.gov.uk/dataset/26d61739-e05b-420d-8fd0-d11edffa8b27/soilscapes

[34] Natural England's Habitat Networks, accessible here: https://environment.data.gov.uk/dataset/5e614b67-ccd0-4673-8ad8-adddf538125e

The scale of potential area for habitat type differs across England, as shown in Figure 4. This illustrates the need for more targeted interventions for certain land uses to maximise the chance of successful establishment of habitats, given the limited potential for some.

**Peat restoration**

Opportunities for peat restoration are much more spatially constrained than tree planting and other habitat creation / restoration. Figure 5 shows locations where peat restoration could occur (assuming that only 'deep' and 'wasted former deep peat' are feasibly restorable). Aside from the current condition of peaty soils in England, there are other site-specific factors which may render peat restoration impossible. Defra is funding research on the feasibility of rewetting peat considering water availability and topography[35].

It is worth noting that existing data on peat extent, depth and condition is considered inadequate and outdated. However, the peaty soils data remains the best data with national coverage available. The England Peat Map[36], due to be published in March 2025, is being developed by Defra's Natural Capital and Ecosystem Assessment (NCEA) programme and aims to map the depth, extent and condition of peat in England.

[35] The LowlandPeat3 project, funded by Defra. Available here: https://lowlandpeat.ceh.ac.uk/lowlandpeat3

[36] The England Peat Map, due to be published March 2025. Announcement accessible here: https://naturalengland.blog.gov.uk/2024/08/06/with-a-lot-of-help-from-our-friends-assembling-an-england-peat-map/

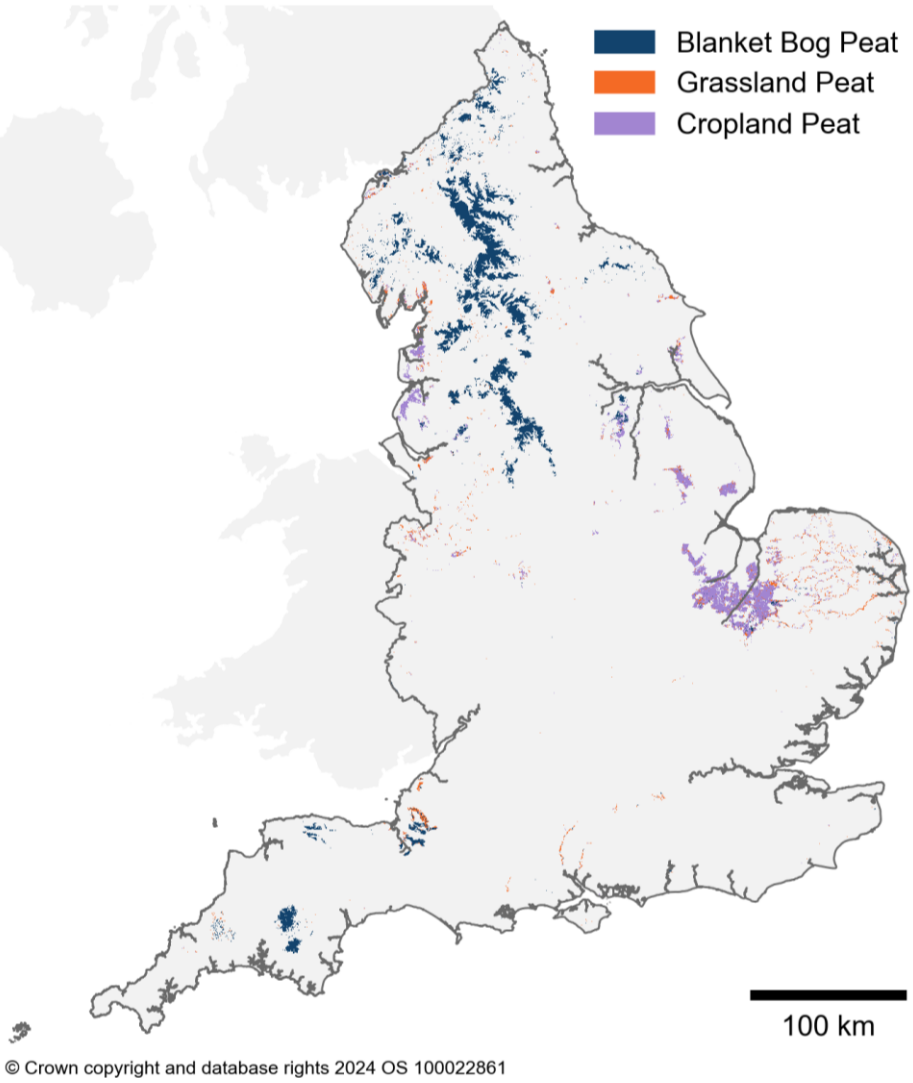


**Figure 5: Map showing the locations where peat restoration could occur across England, using the Peaty Soils data[37].**

## 4.2 The potential of land to support different uses is expected to vary in the future

It is expected that the suitability for different land uses will vary in the future, predominantly due to the impacts of climate change. Figure 6 visualises the impact of climate change on tree growth potential for both baseline and two Representative Concentration Pathway

[37] Peaty soils location data, accessible here: https://www.data.gov.uk/dataset/9d494f48-f0d7-4333-96f0-8b736ac8fb18/peaty-soils-location

(RCP) climate scenarios (RCP2.6 and RCP8.5)[38]. The maps illustrate how tree growth potential could be significantly affected depending on the degree of warming. For example, the data mapped in Figure 6 suggests that the Southeast of England will become less able to support tree growth of currently modelled species in higher emissions scenarios.

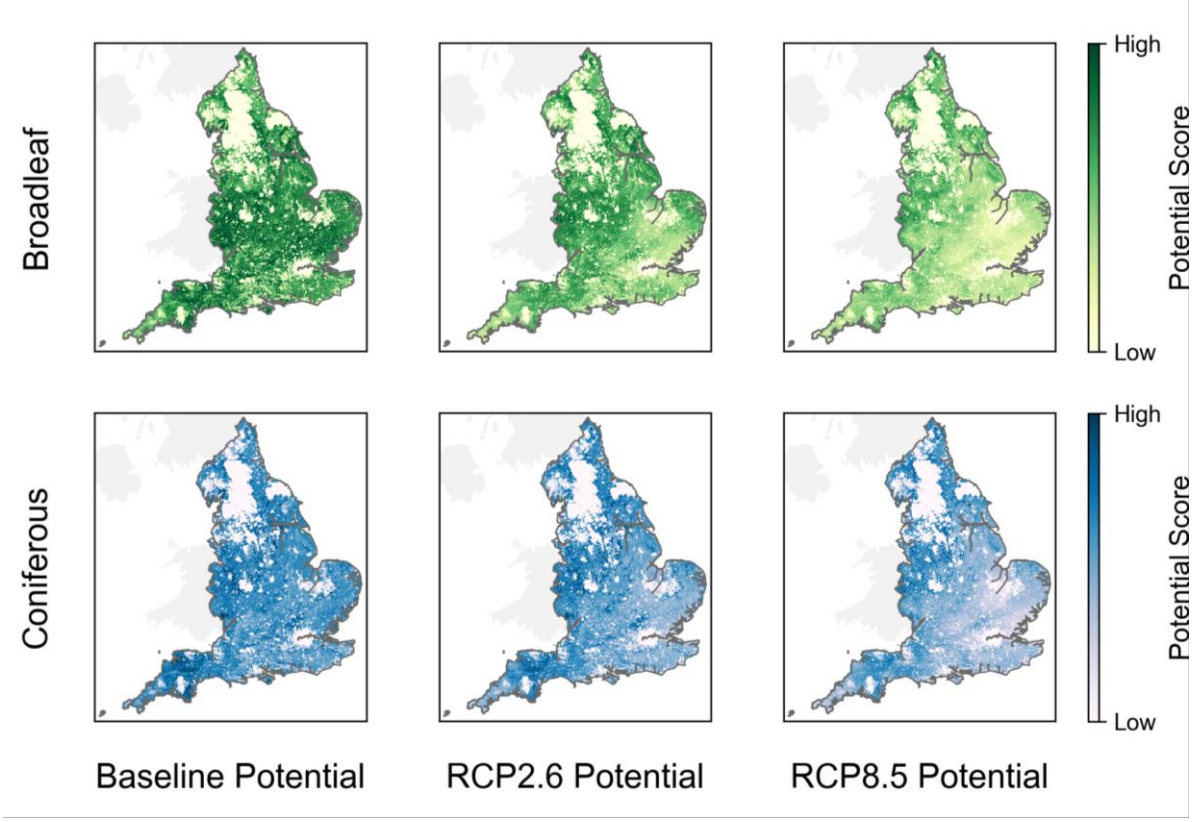


**Figure 6: Maps showing the relative potential for both Broadleaf and Coniferous tree growth across England in 2050 for multiple climate scenarios (baseline, RCP2.6 and RCP8.5). High potential is defined by how well the environmental context (such as soil conditions and climate patterns) enables tree growth. Highly suitable locations exhibit high modelled potential growth rates. Growth potential data is derived from Forest Research's Ecological Site Classification tool[39].**

[38] The RCP pathways represent a broad range of climate outcomes and are neither forecasts nor policy recommendations. RCP2.6 results in an increase of global mean surface temperature of 1.6°C by 2081-2100 compared to the pre-industrial period. RCP8.5 results in a 4.3°C increase.

[39] Forest Research's Ecological Site Classification tool, accessible here: https://www.forestresearch.gov.uk/tools-and-resources/fthr/ecological-site-classification/

## 4.3 Some areas are suitable for more than one land use, indicating potential for multiple benefits but also risks of trade-offs

We have overlayed some of the suitability maps shown above to understand how and where there may be overlapping potentials. For ease of interpretation, we have plotted pairs of land uses, which show the suitability of two land use types simultaneously.

We provide examples of three pairs in this document: (i) tree growth / food production (Figure 7); (ii) tree growth / habitat creation or restoration (Figure 8); and (iii) food production / habitat creation or restoration (Figure 9).

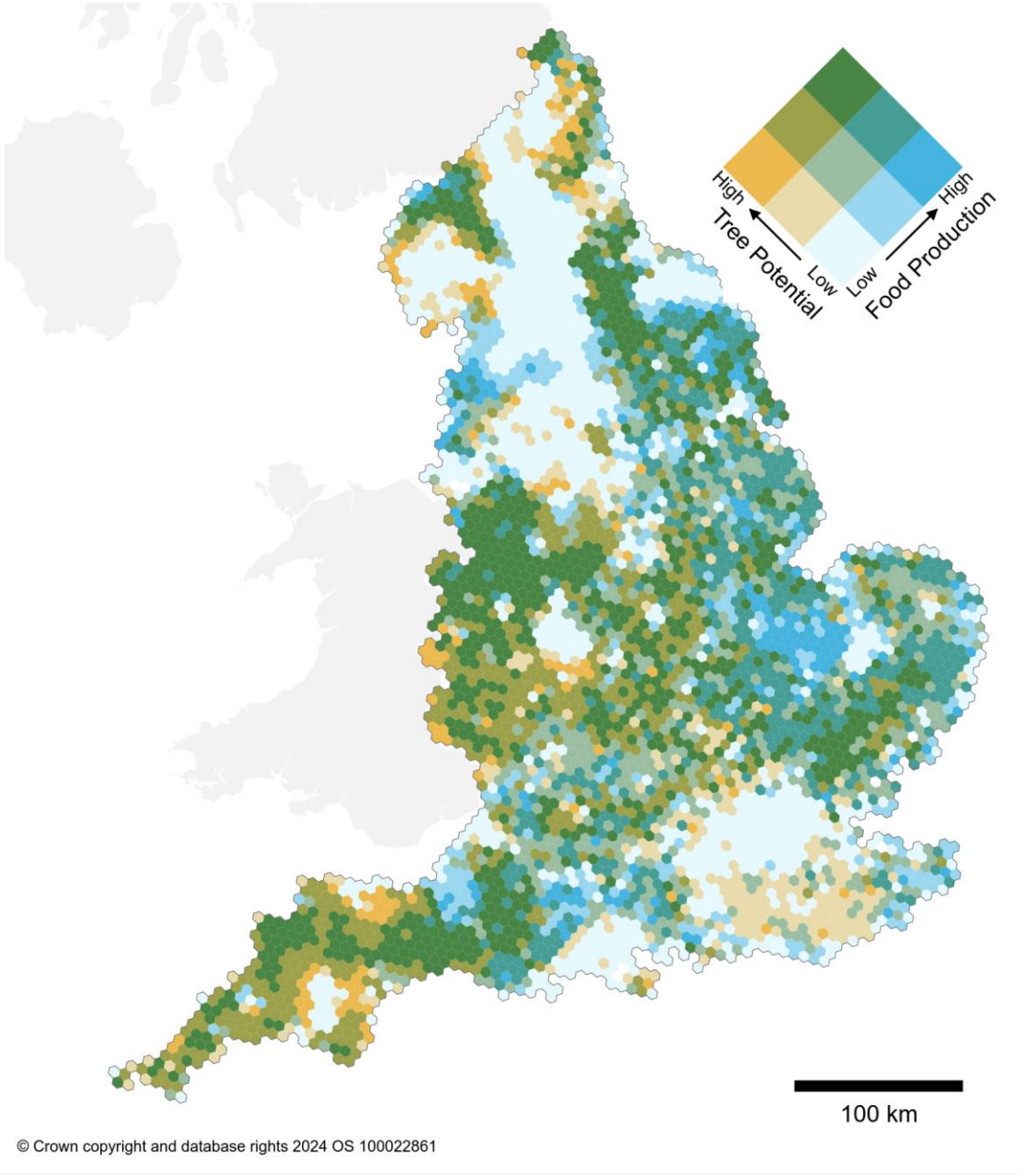


**Figure 7: Suitability for tree growth potential[40] and current food production[41]. Dark green areas are highly suitable for both outcomes. Yellow areas are highly suitable for tree planting while producing less food currently. Blue areas currently produce a lot of food while being less suitable for tree planting.**

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[40] Forest Research's Ecological Site Classification tool, accessible here: https://www.forestresearch.gov.uk/tools-and-resources/fthr/ecological-site-classification/

[41] Using calories as a standardising metric. Derived from June Survey: Department for Food and Rural Affairs. (2019). June survey of agriculture and horticulture. HMG. Available at: https://www.gov.uk/agricultural-survey

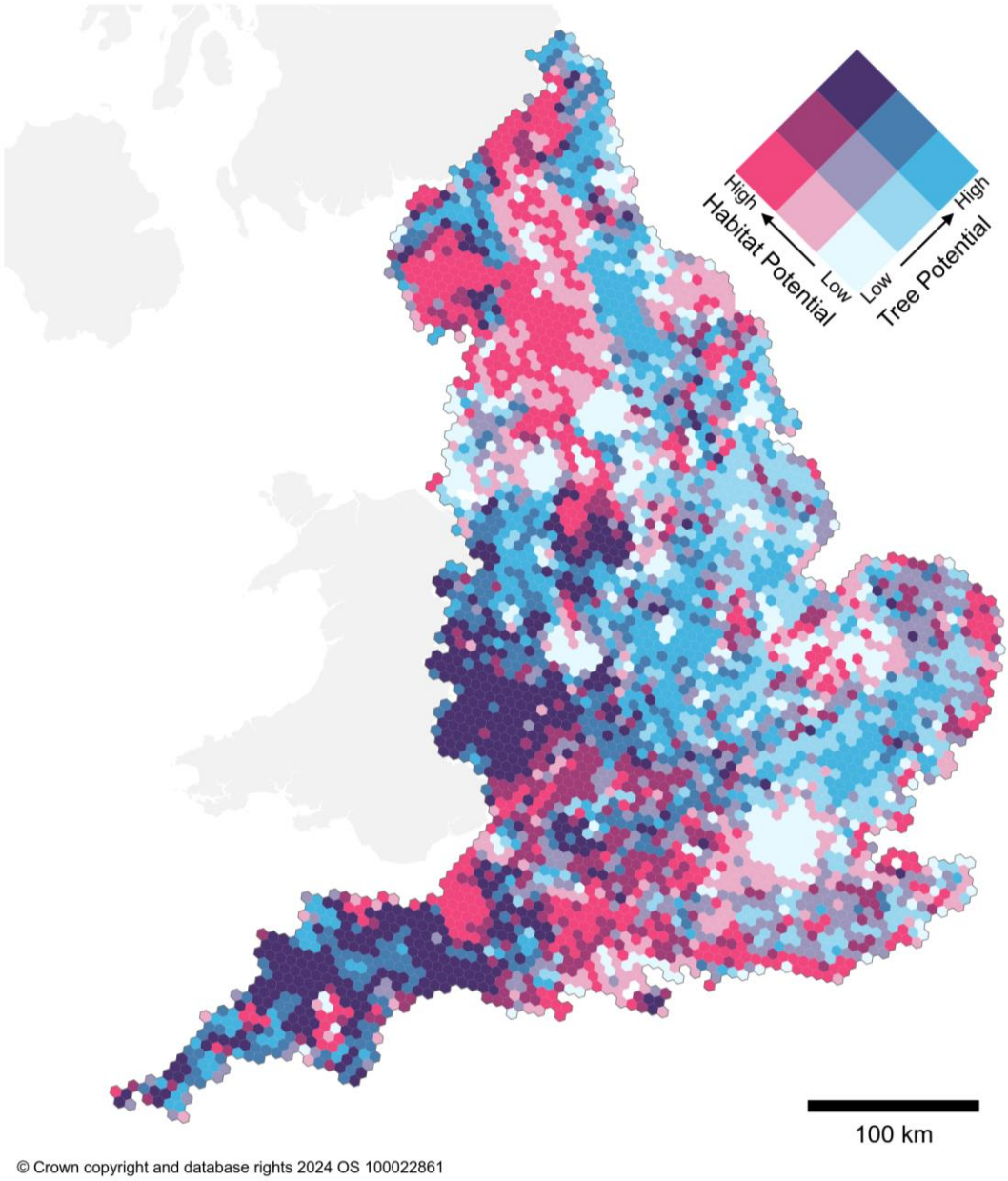


**Figure 8: Suitability for both creating and/or restoring habitat[42] and tree growth potential[43]. Dark purple areas are highly suitable for both outcomes. Pink areas are highly suitable for habitat creation while less so for tree planting. Blue areas are highly suitable for tree planting while being less suitable for habitat creation/restoration.**

[42] Natural England's Habitat Networks, accessible here: https://environment.data.gov.uk/dataset/5e614b67-ccd0-4673-8ad8-adddf538125e

[43] Forest Research's Ecological Site Classification tool, accessible here: https://www.forestresearch.gov.uk/tools-and-resources/fthr/ecological-site-classification/

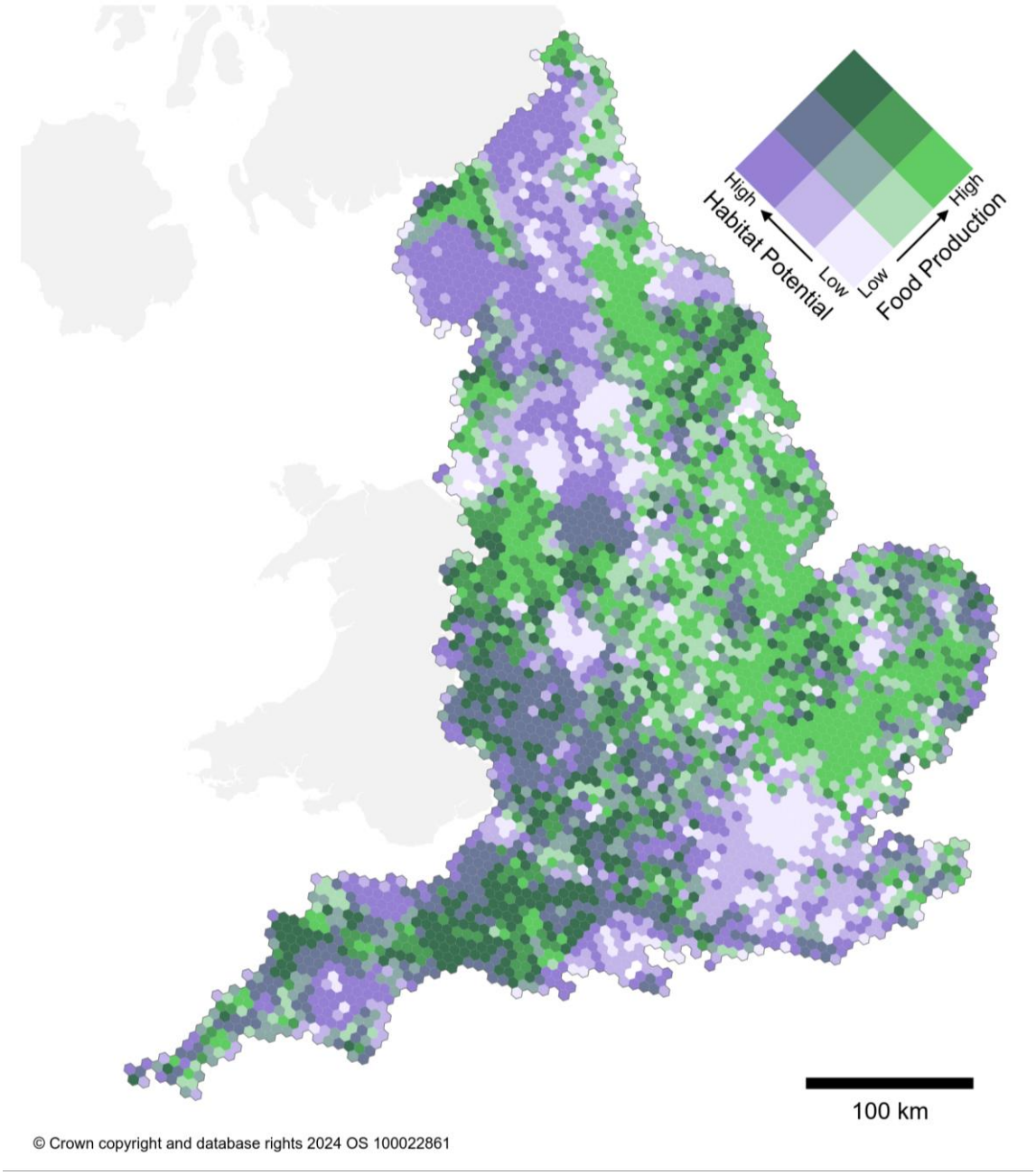


**Figure 9: Suitability for both creating and/or restoring habitat[44] and current food production[45]. Dark green areas are highly suitable for both outcomes. Purple areas are highly suitable for habitat creation while producing less food currently. Green areas currently produce a lot of food while being less suitable for habitat creation.**

[44] Natural England's Habitat Networks, accessible here: https://environment.data.gov.uk/dataset/5e614b67-ccd0-4673-8ad8-adddf538125e

[45] Using calories as a standardising metric. Derived from June Survey: Department for Food and Rural Affairs. (2019). June survey of agriculture and horticulture. HMG. Available at: https://www.gov.uk/agricultural-survey

**Table 5: Examples of insights from looking across suitability for different land uses / outcomes**

| Bivariate map | Example insight |
|---|---|
| Figure 7, Tree growth / food production. | There are parts of the South West and North East that are currently producing a lot of food, but where there is also high growth potential for trees. This could indicate that, pending a site-specific investigation, agroforestry systems could be used to deliver multiple outcomes in these locations. |
| Figure 8, Tree growth / habitat creation or restoration. | There are parts of West Midlands and South West that have high potential to grow trees as well as to create habitat. Given that some habitats have limited opportunity sizes for highly suitable land, as shown in Figure 4, this land use change could be prioritised over less spatially sensitive types to deliver better outcomes across multiple objectives. It may also suggest potential to use forestry to create nature networks between spatially sensitive habitats, pending site-specific ecological investigations. |
| Figure 9, Food production / habitat creation or restoration. | There are several areas in which there is high potential for habitats and high levels of current food production. In these locations, it could be possible to use sustainable farming and land uses such as arable field margins to provide more habitats alongside food production. |

These insights show that the interaction of patterns of suitability can produce potential trade-offs as well as opportunities to deliver co-benefits. This is why it is important to look at the targets simultaneously. Our modelling allows exploration of the spatial distribution of English landcover that emerges when a set of land use change targets are achieved, taking the range of land suitability into account. Findings from this model are detailed in the next section.

## 4.4 The scale of change implied by environmental and climate targets varies across England

The potential spatial distribution of land uses in England in 2050, in a future where targets are met, depends on a range of factors beyond the land take for the targets, land suitability or spatial constraints. To reflect this, we have analysed two simple scenarios: one where we assume changes occur where land is most geographically suitable for new land uses (scenario A); and another in which change occurs where there are lower opportunity costs of shifts away from food production (scenario B). Neither of these scenarios account for potential future climate change, discussed in section 4.2. Extensive work has been done

elsewhere on land use scenarios, and their insights complement our analysis – see Methodological Box 2.

Our scenarios do not reflect the wide range of land use drivers. They are not prescriptive and do not pre-empt policy decisions: we intend for them to illustrate the variability of spatial outcomes from meeting targets (Figure 10). They aim to meet statutory targets and explore the impact of different assumptions on the ways to achieve the same targets. The results are presented at National Character Area (NCA) level[46].

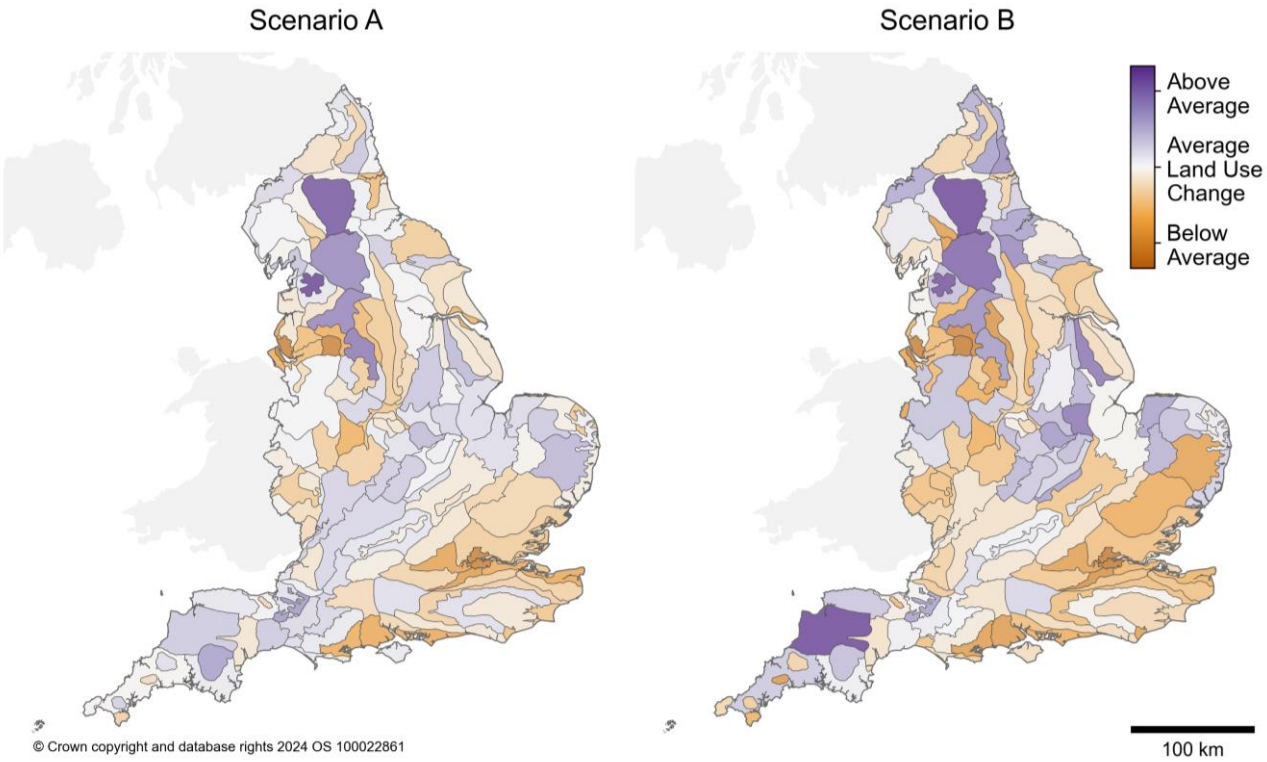


**Figure 10: Modelled relative proportion of land use change in England's National Character Areas (NCAs) in 2050, compared to the national proportion of change of around a fifth of agricultural land (see section 3). Modelling was done in two different scenarios (see text).**

This illustrates that while biophysical potential is likely to have a strong impact on where land use change might occur, wider factors such as agricultural markets and the policy approach to delivery will also be a strong driver of the geographic distribution of land use change.

[46] NCAs are defined by a unique combination of: landscape, biodiversity, geodiversity, history and cultural/economic activity. The boundaries tend to follow natural lines in the landscape, not county or district boundaries. National Character Areas are accessible here: https://www.gov.uk/guidance/national-character-area-profiles-information-for-local-decision-making

**Methodological Box 2: Land use scenarios in other work**

Different organisations have taken different approaches to LUC scenario analysis, examining different aspects of LUC systems, and yielding different, but complementary, findings. For example:

- The international organisation, *The Food, Agriculture, Biodiversity, Land-Use, and Energy* (FABLE) Consortium works to "develop national pathways that are consistent with global sustainability objectives, including the Sustainable Development Goals (SDGs) and the Paris Climate Agreement targets." [47]
- The Welsh Government's Environment and Rural Affairs Monitoring & Modelling Programme (ERAMMP) involves a computer model, co-funded by the UK Centre for Ecology & Hydrology (UKCEH), called the Integrated Modelling Platform (IMP). The IMP provides "rapid, integrated assessments of the impacts of changing policy or economic scenarios on agriculture and the natural environment"[48].
- The RSPB's Land Use Scenarios project[49] quantified trade-offs and co-benefits between different national objectives by predicting the impacts on greenhouse gas emissions, bird populations and food and timber production of nine spatially explicit pathways for UK land.

## 4.5 The relationship between land use change and food production

Food production is a key output of land and represents one of the 'provisioning' services of our natural capital. The land use changes set out in this document imply an impact on food production against a counterfactual of 'no land use change' (land use today). In reality, whilst land use has generally changed slowly over time, it has not remained fixed. Land use and agricultural sector composition will likely change in future in response to climate change and other drivers. As described in section 3, there are multiple opportunities for nature and food production to co-exist in multifunctional landscapes on rural land.

We have assessed the impact on domestic food production of these land use changes. Our overall assessment is that it is plausible – with continued growth in the food output we can produce on our land and reasonable market conditions – that food production levels could be maintained or moderately increased alongside the land use change required to meet our

[47] https://fableconsortium.org/about/

[48] https://erammp.wales/en/modelling/integrated-monitoring-platform

[49] Finch, T., Bradbury, R.B., Bradfer-Lawrence, T., Buchanan, G.M., Copping, J.P., Massimino, D., Smith, P., Peach, W.J., Field, R.H., *Spatially targeted nature-based solutions can mitigate climate change and nature loss but require a systems approach* https://doi.org/10.1016/j.oneear.2023.09.005

Net Zero and Environment Act targets and commitments. Given the long-term nature of the analysis, this is subject to significant uncertainty.

This is how we have come to our conclusion that food production levels could be maintained or moderately increased alongside land use change:

- Our assessment first apportioned the expected levels of land use change across different farm types. Pigs and poultry, for example, are likely to be less affected by land use change than extensive livestock production, given the differing production characteristics of sectors.
- Our analysis then estimated the required 'background' growth of food production on land – from productivity and compositional factors - to offset the impact of land use changes. To do that, we first estimated what the reduction of the overall value of agricultural production due to land use change (categories 1 to 4) would hypothetically be *in isolation,* in 2050 compared to today.
- We then calculated what the equivalent 'background' growth rate of food production on land would be required to offset this reduction. We estimated that rate to be 0.5% per annum on average to 2050.
- In comparison to this required rate, the long-term trend is one of overall improvement in total factor productivity (TFP). Since the series began in 1973, TFP has increased by nearly 60%, driven by an increase in the volume of all outputs by 32% and a decrease in the volume of all inputs by 17%. If such historical trends continue, land use change impacts on food production could be broadly offset.
- Defra's UK Agricultural Markets Model (UKAMM) provides another means of comparison[50]. UKAMM makes a projection for a set of agricultural products for production, prices, and trade amongst other parameters of interest. Using the UKAMM projection across agricultural production implies a 0.7% increase in production per annum in the future, which exceeds the required growth to offset the impact of land use change.

There are uncertainties in this analysis - inherent uncertainties exist in projecting far into the future. This assessment is based on assumptions about where land use change could occur, which will need to be monitored and reassessed. It does not include an explicit assessment of the effects of increased extreme weather (which would affect production with or without land use change). Nonetheless, this indicative analysis suggests that land use change could be consistent with maintaining or even potentially increasing food production in England.

It is worth noting that Government has published a broader assessment of food security in the UK in its latest Food Security Report[51].

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[50] https://www.gov.uk/government/publications/uk-agricultural-market-model-ukamm

[51] https://www.gov.uk/government/statistics/united-kingdom-food-security-report-2024

**Methodological Box 3: Work by other organisations on resolving tensions between environmental land use and food production**

As described above, our analysis suggests that it is plausible that increases in the 'background' growth of food production could increase farm output sufficiently to offset production losses implied by the land use changes required to meet Net Zero and Environment Act targets and commitments. This is similar to the conclusions of some organisations and reports which have made reference to a "three compartment model" for land use in England[52]. In this conceptual model, a proportion of land devoted primarily to sustainable but higher intensity food production sits alongside areas of land dedicated solely to environment and climate benefits, and areas of land providing both food and environmental / climate benefits, thereby broadly maintaining overall levels of domestic production, while simultaneously making space for nature and emissions reductions.

## 4.6 The transition would differ across landscapes

The maps in section 4.4 show that meeting targets implies different types and degrees of land use change in different parts of the country. We found that the spatial patterns resulting from our modelling could be categorised into four broad landscape types (Methodological Box 4). This allows us to assess what commitments and targets may mean for the diversity of England's landscapes.

**Methodological Box 4: How we identified our four broad landscape types**

National Character Areas (NCAs) were grouped into landscape types using a clustering algorithm called "k-means". The algorithm looked at the characteristics of the NCAs in terms of their modelled land uses, and determined how best to group them, so that the differences between NCAs were minimal for those in the same group, but maximal for those in different groups. It produced two outputs: the optimal number of groups (in this case, four), and membership of NCAs across the groups.

Figure 11 outlines four landscape types that may result from meeting environmental and climate targets (2050). It is worth noting that they each include a diversity of possible landscapes that do not all look the same but do share similar characteristics. This Figure provides a comparison between outcomes currently delivered and those that could be delivered in 2050. It shows how the land use transition is about moving to more varied landscapes that deliver a broader scope of market and non-market values on average than current land uses.

**Four landscape types that may result from meeting environmental and climate targets (2050)**

[52] See for instance the Royal Society's Multifunctional Landscapes report: https://royalsociety.org/-/media/policy/projects/living-landscapes/des7483_multifunctional-landscapes_policy-report-web.pdf

| **Outcomes Key:** | Food (higher-grade land) · Food (lower-grade land) · Food and Climate · Built-up · Nature · Nature and Climate · Climate |
|---|---|
| **Landscape type:** Predominantly food producing | |
| **Present Day Outcomes:**  **2050 Outcomes:**  | **Description:**<br>• Much of the area is made up of high quality, productive agricultural land under intensive cultivation. It includes most of the country's lowland peat.<br>• Includes most of the East of England.<br>• Offers opportunities for multifunctional land uses such as field margins, and silvoarable agro-forestry, as well as diversification into biomass crops. The restoration of lowland peatlands here could contribute to climate as well as habitat targets. |
| **Landscape type:** Mixed land use | |
| **Present Day Outcomes:**  **2050 Outcomes:**  | **Description:**<br>• Largely general purpose agricultural land, much of which favours pasture.<br>• Includes South-West and West of England.<br>• Offers opportunities for woodland and habitat creation particularly on the less productive land. |
| **Landscape type:** Uplands | |
| **Present Day Outcomes:**  **2050 Outcomes:**  | **Description:**<br>• Lower grade agricultural land often in more rugged, mountain and moorland settings and used for extensive grazing. Includes much of England's peatlands.<br>• Offers opportunities for habitat creation and nature as well as storage of carbon in restored peatlands. |
| **Landscape type:** Predominantly built-up | |
| **Present Day Outcomes:**  **2050 Outcomes:**  | **Description:**<br>• Includes areas of conurbation such as Greater London, Greater Manchester, Liverpool and Merseyside, South Hampshire, West Yorkshire, and the West Midlands.<br>• Land is predominantly developed, intermixed with other land uses.<br>• Offers opportunities for land uses supporting nature-based solutions, and creation of woodlands and habitats providing recreational opportunities. |

**Figure 11: Plots illustrating the four landscape types that may result from meeting environmental and climate targets by 2050. We include outcomes currently being delivered as comparison. We also describe the specific land use opportunities associated with transitioning to 2050 outcomes.**

# 5 Key drivers and opportunities for the land use transition

The land use transition described in previous sections should be understood in the context of social, economic and cultural drivers of land use change.

We derived key drivers, barriers and complexity of the land use system from insights generated through a survey, place-based deliberative workshops and semi-structured interviews, and supported by published research.

**Methodology Box 5: Systems analysis and research**

In March 2022, we conducted an online and paper-based survey to understand land managers' attitudes towards the land use changes required to meet environmental targets. The survey was distributed to tenant and land-owning farmers (n = 2,000), National Park estate managers (n = 200), National Trust estate managers (n= 500), Church of England estate managers (approximately 200), and nature and environmental conservation charities (approximately 100). We received 529 responses, comprising 137 online submissions and 392 paper-based responses, resulting in an overall response rate of around 18%. Whilst the responses were not necessarily a representative sample, the significant response allowed us to draw illustrative insights, which were further explored in place-based workshops (Report awaiting publication).

In 2022, the Defra Systems Research Programme organised four sets of deliberative workshops with regional farmer groups from Cumbria, Northamptonshire / Lincolnshire, Cornwall / Devon, and Suffolk / Essex to gather their perspectives on Defra's land use scenarios and identify place-based barriers and opportunities for land use change in each region. These workshops were co-facilitated through the UK Farmer Discussion Group Network[53] coordinated by Professor Alex Inman from the University of Exeter. (Report awaiting publication)

In 2023, we conducted semi-structured interviews with a range of land use actors (for example, local authorities, farmer clusters, agricultural colleges) to identify barriers to effective decision making, role of governance structures, intervention points to improve governance, and knowledge-capacity gaps that need closing to facilitate land use transitions. We have also conducted desk research and internal workshops to map out the drivers of the land use system. This work was undertaken in partnership with DESNZ Net Zero Systems Tool team. Some of the literature reviewed is included in footnotes in this section.

[53] https://www.farmergroupdiscussion.org/

## 5.1 Land use decisions are driven by complex dynamics

Decisions are constantly being made that increase or decrease the value of services provided by England's land. These decisions are affected by a range of interacting factors at local, national and global scales. Their influence varies over time in line with new developments such as innovation and technology, markets, skills and changes in climate. We have identified some of the key complexities of land use change decisions through our engagement, notably via place-based workshops with regional farmer groups.

**Coherent decision-making**

A significant portion of land in England is privately owned and landowners' priorities shape how their land is used. We know from our workshops and the literature[54] that the interests of some actors such as landowners and land managers (for instance tenants) and non-agricultural landowners (such as conservation charities) may not always align, complicating coherent land use change.

**Market dynamics**

From our research with land use actors, we know that the market for food products remains the most established, valuable, and reliable outlet for land-derived goods and services. In contrast, markets for environmental goods and services are in some cases still in their early stages and this causes uncertainty amongst landowners[55,56]. A large proportion (51%) of the land managers who responded to our survey stated that predictable income would motivate them to undertake land use change. The flexibility of the agri-food market allows farmers to switch crops and commodities based on market prices, while environmental markets often require semi-permanent or permanent land use changes. Many actors perceived that these changes could render land temporarily or permanently unsuitable for food production, a key factor in determining land's economic value, which is used as financial security for loans.

**Cultural identity and perceptions**

Based on workshops, interviews and survey responses, we ascertained that the established definition and notion of a 'good farmer' within the UK farming community continues to shape

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[54] 2021 Review of Key Trends and Issues in UK Rural Land Use - Report to The Royal Society https://royalsociety.org/-/media/policy/publications/2020/2020-09-18-commissioned-report-history-uk-land-use-decision-making.pdf

[55] 2023 Reforming environmental markets Making them work for nature and communities https://www.wcl.org.uk/docs/Reforming_environmental_markets_Link_report_March_2023.pdf

[56] 2022 The opportunities of agri-carbon markets: A summary (By WWF and Tesco Partnership) https://www.wwf.org.uk/sites/default/files/2021-12/The_opportunities_of_agri-carbon_markets_summary.pdf

land use change decisions. 91.2% of the land managers who responded to our survey agreed that farming was a way of life and that they take pride in the heritage of farming and the local landscape. Food production is seen by many farmers as a core part of their identity, meaning that land use changes for environmental purposes can feel a threat to their way of life and identity[57,58]. In some areas, there are deeply held beliefs about certain land uses being part of the aesthetics of rural landscapes. This hinders the adoption of changes perceived to negatively affect landscape character and local farming communities.

## 5.2 Opportunities to improve environmental and climate outcomes through land use change

Meeting environmental, climate, housing and infrastructure objectives through land use change is complex. Our engagement with farmers, land managers and other land use actors across the country has allowed us to understand the challenges to improving environmental and climate outcomes and therefore also the opportunities to leverage change. We identified several opportunities that cluster into three key themes:

- Establishing joined-up decision making
- Aligning incentives
- Building capacity and knowledge

**Establishing joined-up decision making**

Land is in high demand for housing, infrastructure, agriculture, and environmental uses, each governed by distinct institutions and regulatory frameworks at various levels. In some cases, governance structures do not align with natural ecological boundaries, like landscapes and catchments. We have found from our workshops, interviews and survey that this lack of alignment limits the ability of governance structures to drive coherent land use changes and prioritise environmental outcomes. Our workshops, interviews and survey also identified that this misalignment results in unclear decision-making processes, reducing transparency and accountability, and hindering the strategic prioritisation of competing land demands. A large proportion (51%) of land managers who responded to our survey had low levels of trust in government environmental strategies and could not see the benefits for

[57] 2016 Warren, C.R., R.Burton, O.Buchanan and R.V.Birnie.. Limited adoption of biomass energy crops: the role of farmers' identity and farming culture. Journal of Rural Studies 45C: 175-183. DOI: 10.1016/j.jrurstud.2016.03.017 https://research-repository.st-andrews.ac.uk/bitstream/handle/10023/11841/Scottish_farmers_and_SRC_accepted.pdf;jsessionid=FA3CF2BA10B867C3D3430633AB099137?sequence=1

[58] 2024 Characterizing culture's influence in land systems https://www.nature.com/articles/s41893-024-01381-z

local communities and businesses. Establishing coherent and transparent decision-making structures could improve the co-ordination and prioritisation of land use change.

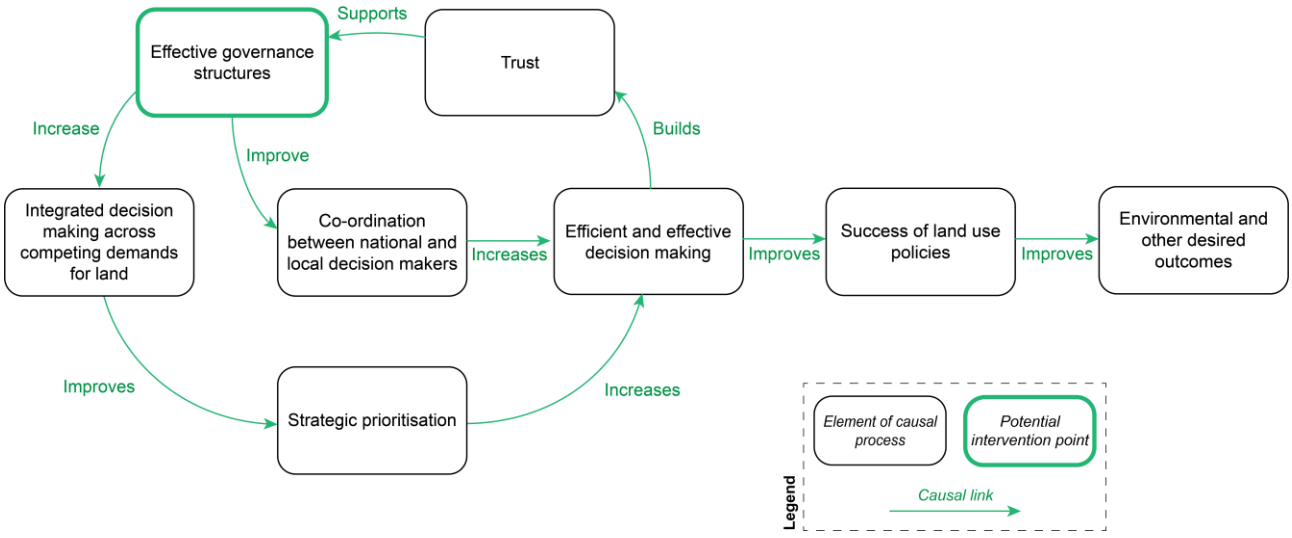


**Figure 12: A simplified cause-effect diagram illustrating how effective governance structures lead to improved decision-making, build trust and ensure the success of land use policies in delivering better environmental outcomes. This is based on synthesis of insights from our engagement.**

### Aligning incentives

In our engagement with land use actors, we identified that the incentives for adopting positive land use practices and the disincentives for harmful land management do not always align with government priorities. Participants raised that a lack of flexibility makes some land use / management options less attractive to farmers, especially given the increasing uncertainty of climate conditions. Emerging nature markets (both voluntary and compliance based) could offer additional incentives for adopting positive land use practices: almost all participants stressed the need for regulation and standardisation to build trust in these markets for them to be effective tools for land use change. Additionally, participants suggested that regulation and other interventions, such as clear guidance and maps, may help mitigate against environmentally damaging practices.

Different actors observe and experience distinct parts of the land use system. Participants emphasised that due to spatial variation, it can be challenging for all actors, including government, to fully understand and accurately assess the realities of land use change and management across different regions and spatial contexts.

Better aligning the incentives and disincentives for land use change, along with establishing a shared understanding of the land use system offers an opportunity to achieve better environmental and climate outcomes.

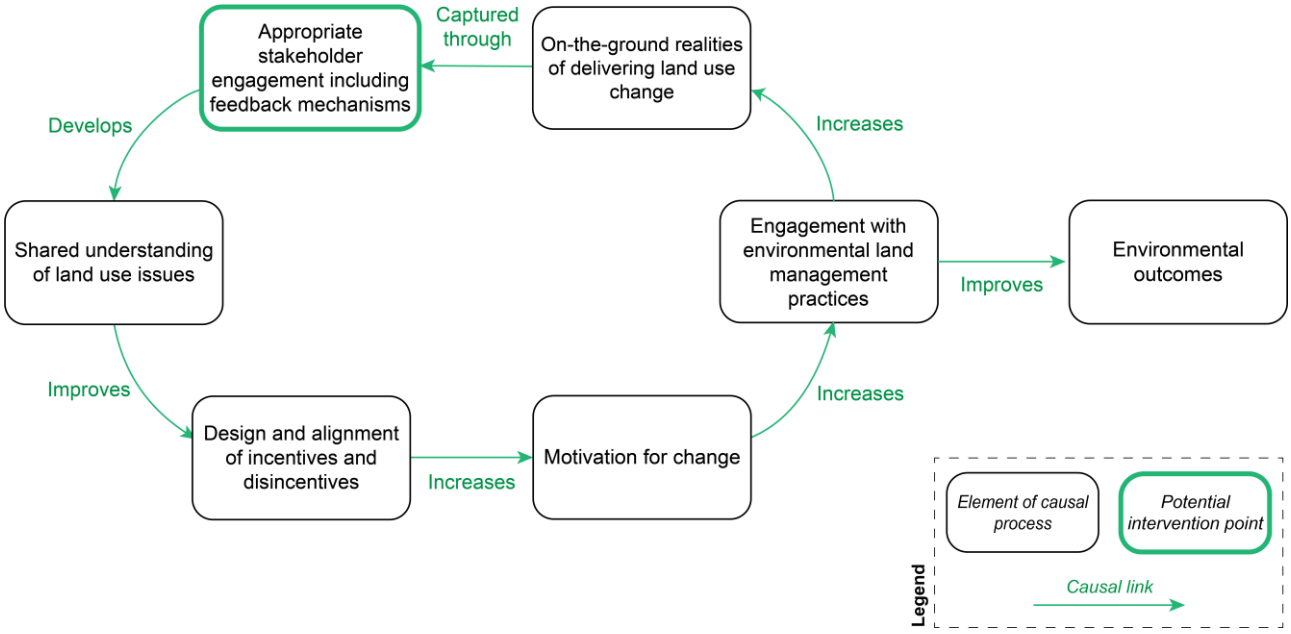


**Figure 13: A simplified cause-effect diagram illustrating how aligning motivations, incentives, and disincentives can promote the uptake of environmental land use and management practices. This is based on synthesis of insights from our engagement.**

### Building capacity and knowledge

We know from our engagement with land use actors, that gaps in capacity, knowledge and skills are barriers to land use change. Participants noted that skills gaps for designing and implementing environmental land uses and management practices limit farmers' and land managers' ability to improve environmental outcomes and maintain and enhance the condition of natural assets. From our engagement we also found that removing barriers to the development and adoption of innovation and technology can improve yields and productivity; maximising yields in some parts while facilitating more environmentally beneficial land uses in other parts. Participants also felt that government evidence and data were not always easy to access, which they identified as a factor that limited their trust, engagement, acceptability and uptake of land use policies.

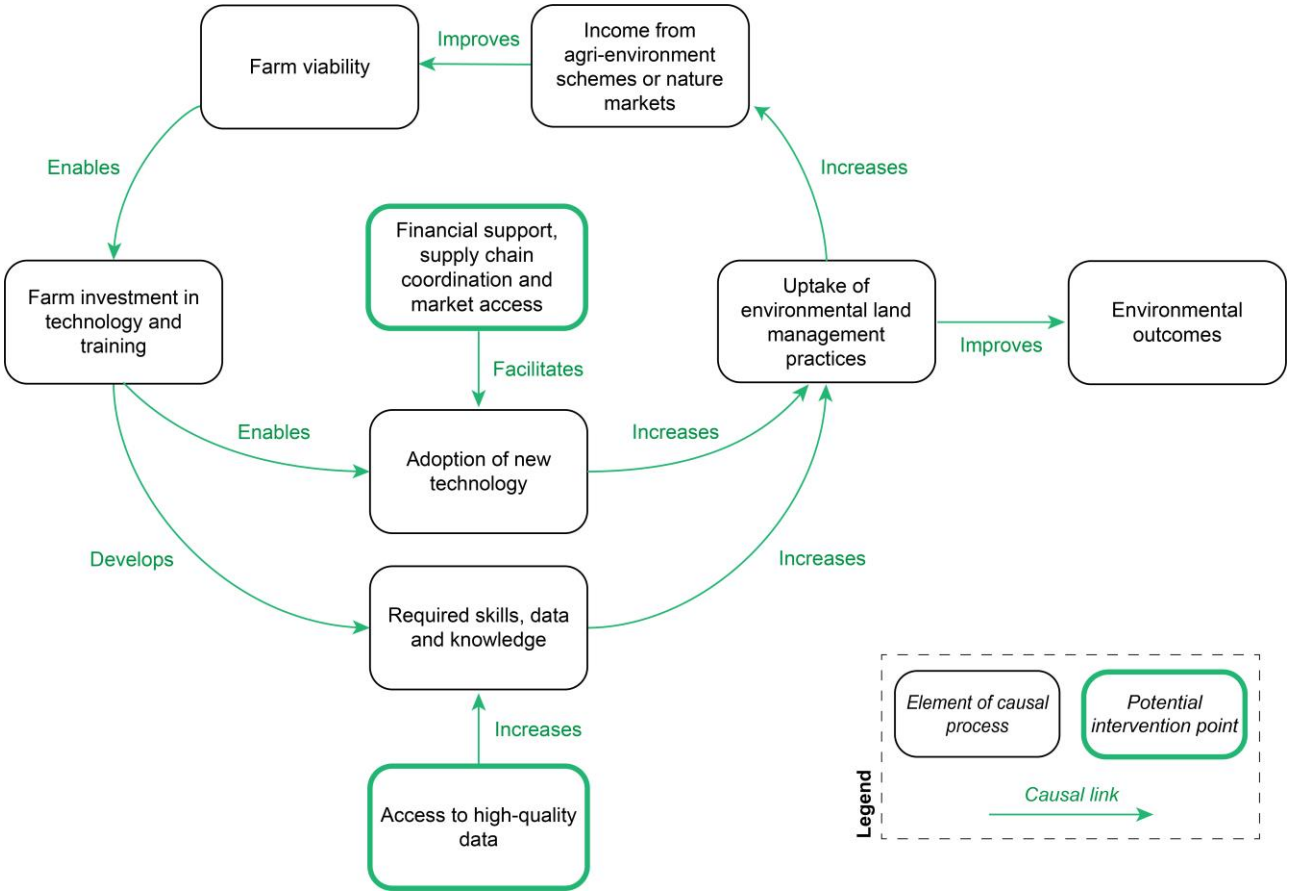


**Figure 14: A simplified cause-effect diagram illustrating how the provision of skills, data, and innovation can enhance business viability and improve environmental outcomes from land use change. This is based on synthesis of insights from our engagement.**

# 6 Next steps

We are taking a co-creation approach to the Land Use Consultation. We intend for the evidence presented in this document to inform responses to the consultation and start conversations on the land use transition.

The consultation will further improve our body of evidence with knowledge from the diversity of expertise, perspectives, and lived experiences on land use and land use change.

We will continue to invest in analysis and research to improve our understanding of land use implications of Government's targets and commitments, and how they can be met in the context of social, economic and cultural drivers of land use change. This involves continued collaboration and knowledge sharing with a wide range of organisations.