Monitoring and evaluating the National Adaptation Programme

Agriculture and Forestry theme:

- Water demand by agriculture
- Flooding of agricultural land
- Fertility of agricultural soils
- Climatic suitability of tree species
- Prevalence of new and existing pests and diseases
- Innovation and knowledge transfer

Last updated: 30 June 2015

Introduction

- This slidepack:
  - Serves as a technical annex to **Chapter 5: Agriculture and Forestry** in the ASC's first statutory report to Parliament on the National Adaptation Programme, available at www.theccc.org.uk/publications
  - Provides the latest trend information on indicators of exposure, vulnerability, action and realised impacts that informed the ASC's assessment. A full list of indicators used by the ASC across all six NAP themes is available at www.theccc.org.uk/publications
  - Will be updated periodically as new data becomes available.
  - Highlights indicators that would be useful but where the necessary datasets have not yet been identified.
  - Follows the structure of the agriculture and forestry chapter in the ASC's progress report, which is based on the 'adaptation priorities' the ASC identified for agriculture and forestry.
- After presenting a high level summary of the ASC's assessment of progress against each of the adaptation priorities, this annex sets out the underlying data by adaptation priority.

Agriculture and Forestry theme: overview of progress

Adaptation priority	Is there a plan?	Are actions taking place?	Is progress being made?
1. Water demand by agriculture			
2. Flooding of agricultural land			
3. Fertility of agricultural soils			
4. Climatic suitability of tree species			
5. Prevalence of new and existing pests and diseases			
6. Innovation and knowledge transfer			

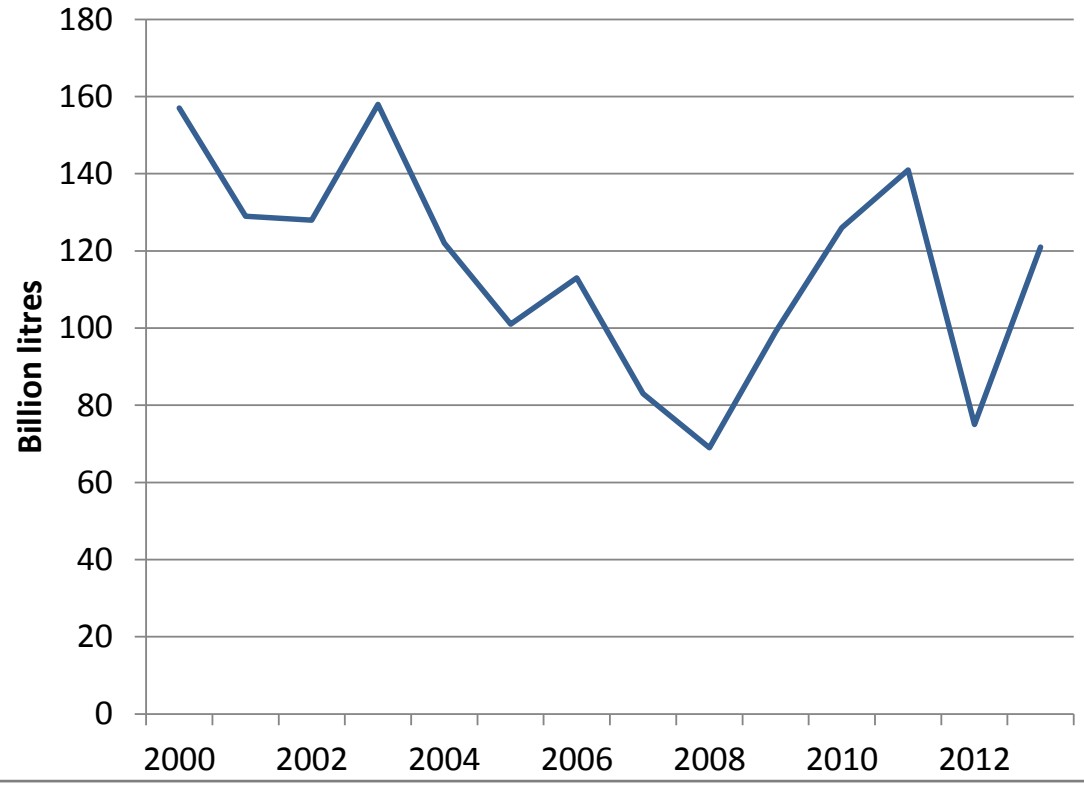
Red: plans and policies, delivery of actions, or progress in addressing vulnerabilities, are lacking.
Amber: adaptation priority has been partially addressed, some evidence of progress in some areas.
Green: plans are in place, actions are being delivered, progress is being made.
Grey: insufficient evidence to form a judgement.

1. Water demand by agriculture

Measure	Data series	Source	Trend	Implication
Total abstraction for agriculture	2000 to 2013	EA abstraction data	↓	Reduces likelihood of supply-demand deficits, damage to the natural environment and the associated negative impacts on agriculture
Total water demand for irrigation	1990 to 2012	Cranfield University (2015) for the ASC	↓	Reduces likelihood of supply-demand deficits, damage to the natural environment and the associated negative impacts on agriculture
Total water demand for livestock	1984 to 2014	Cranfield University (2015) for the ASC	↔	May increase likelihood of supply-demand deficits, damage to the natural environment and the associated negative impacts on agriculture
Area of crops in climatically suitable locations	2000 and 2010	Cranfield University (2013) for the ASC	↔	Concentration of agriculture in areas at greatest risk of current and future water scarcity could limit ability of agriculture to take advantage of future opportunities to increase production with climate change
Total volume of water abstracted for winter storage (on-farm reservoirs)	2007 to 2013	RDPE for England and EA abstraction data	↔	On-farm storage reservoirs reduce pressure on water resources during summer months and provide additional reserves for farmers when water is scarce

1. Water demand by agriculture

Total abstraction for agriculture	↓	Reduces likelihood of supply-demand deficits, damage to the natural environment and the associated negative impacts on agriculture

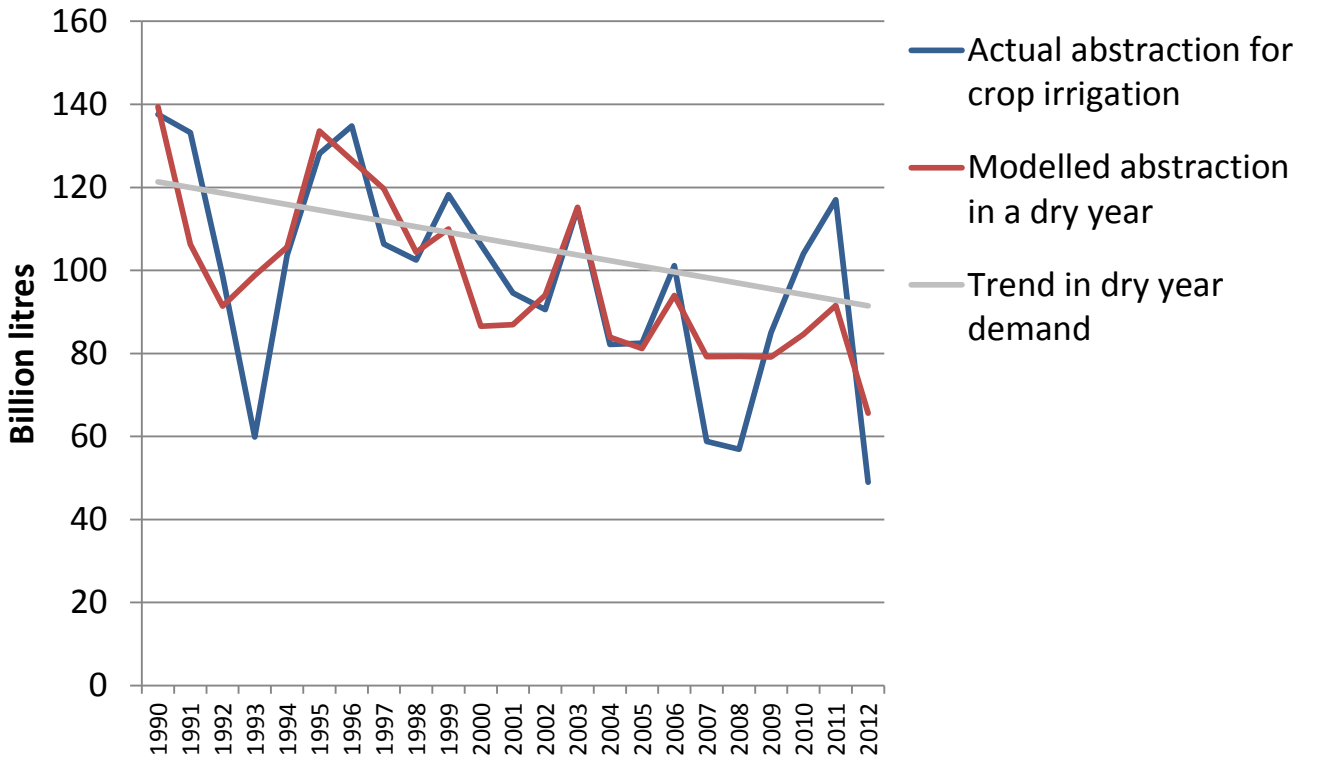


Source: Environment Agency.
Notes: Abstraction from freshwater sources only. Time series back to 1973 available in Cranfield University (2015) for the ASC.

- The volume of water abstracted for agriculture increased markedly in the late 1980s. It has since declined, but it is not as low as the levels in the 1970s.

1. Water demand by agriculture

Total water demand for irrigation	↓	Reduces likelihood of supply-demand deficits, damage to the natural environment and the associated negative impacts on agriculture



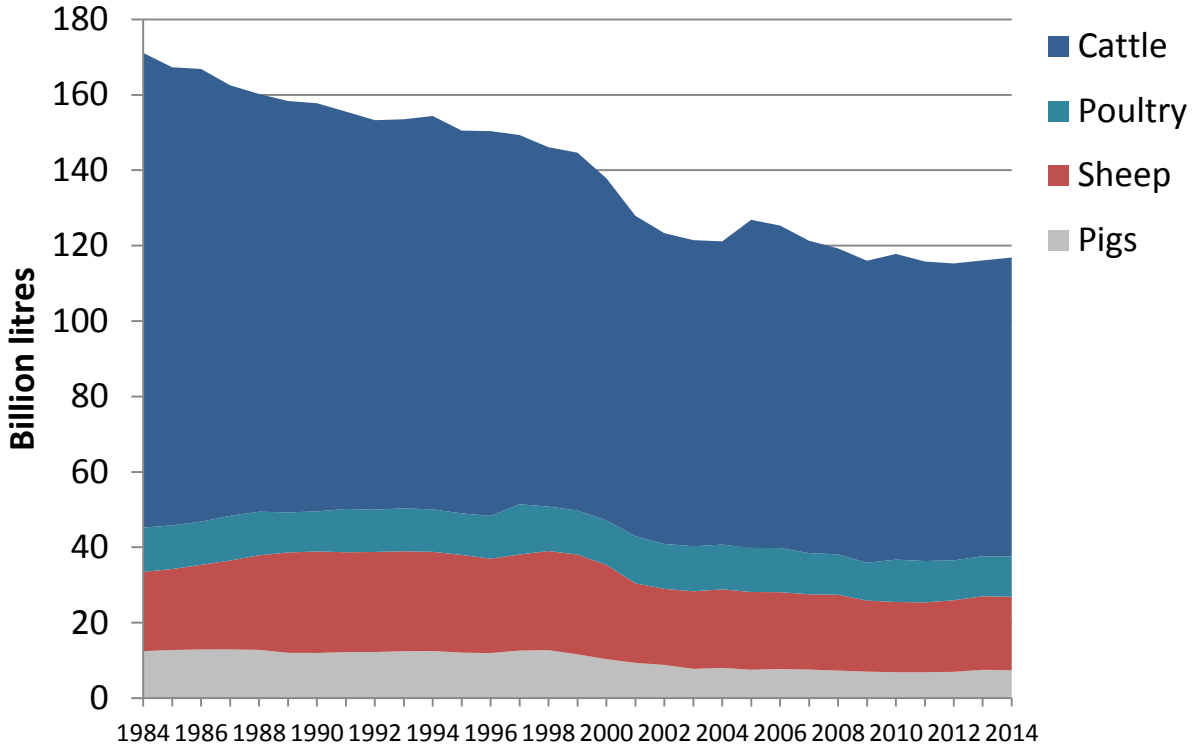
Source: Cranfield University (2015) for the ASC.

Notes: The modelled dry year demand (shown by the red line) has been calculated by correcting the actual abstraction volumes (blue line) for annual weather variation using an indicator of the potential soil moisture deficit (PSMD). The dry year demand shows the amount that would have been abstracted each year if it had been a design dry year, taken as a year with an 80% probability of non-exceedance (approximately the 16th driest year in 20). This graph has been updated from Weatherhead et al. (2013).

- Water demand for crop irrigation in a dry year is estimated to have fallen by 1.4% per year between 1990 and 2012.
- The decline in demand could have been caused by the cropped area of potatoes falling by a third between 1990 and 2010. Potatoes are one of the most water intensive crops. Results from the Defra irrigation survey suggest the depth of water applied for potatoes (volume per unit area) has also fallen, indicating improvements in water efficiency.

1. Water demand by agriculture

Total livestock water demand	↔	May increase likelihood of supply-demand deficits, damage to the natural environment and the associated negative impacts on agriculture

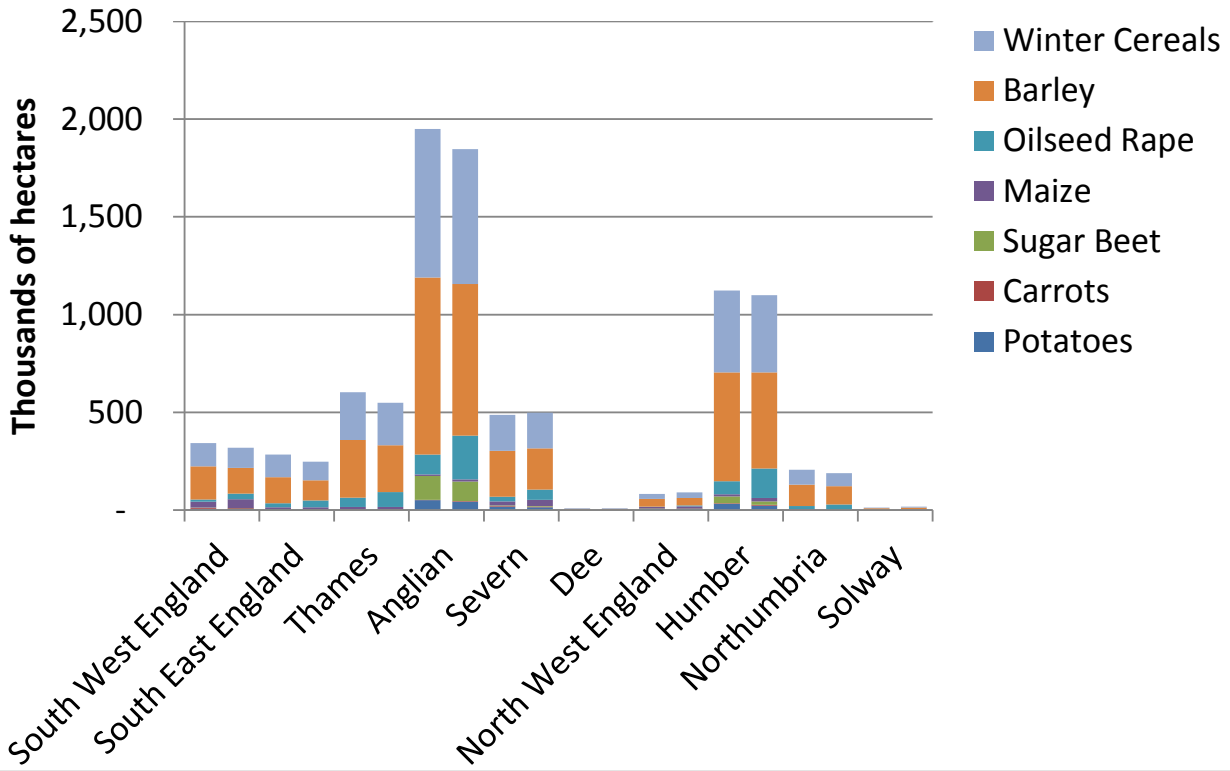


Source: Cranfield University (2015) for the ASC.
Notes: Total livestock water demand has been calculated by multiplying the number of each livestock category by the estimated water use per head. The water use per head figures include both water for drinking and washing, and take into account the the age and size of animals, the composition of their diets and ambient temperatures.

- Livestock water demand declined steadily between 1984 and 2000. It has since stabilised at around 120 billion litres of water a year.
- Cattle (beef and dairy) accounted for 68% of livestock water demand in 2014, sheep 16%, poultry 9% and pigs 7%.

1. Water demand by agriculture

Area of crops in climatically suitable areas	↔	Concentration of agriculture in areas at greatest risk of current and future water scarcity could limit ability of agriculture to take advantage of future opportunities to increase production with climate change

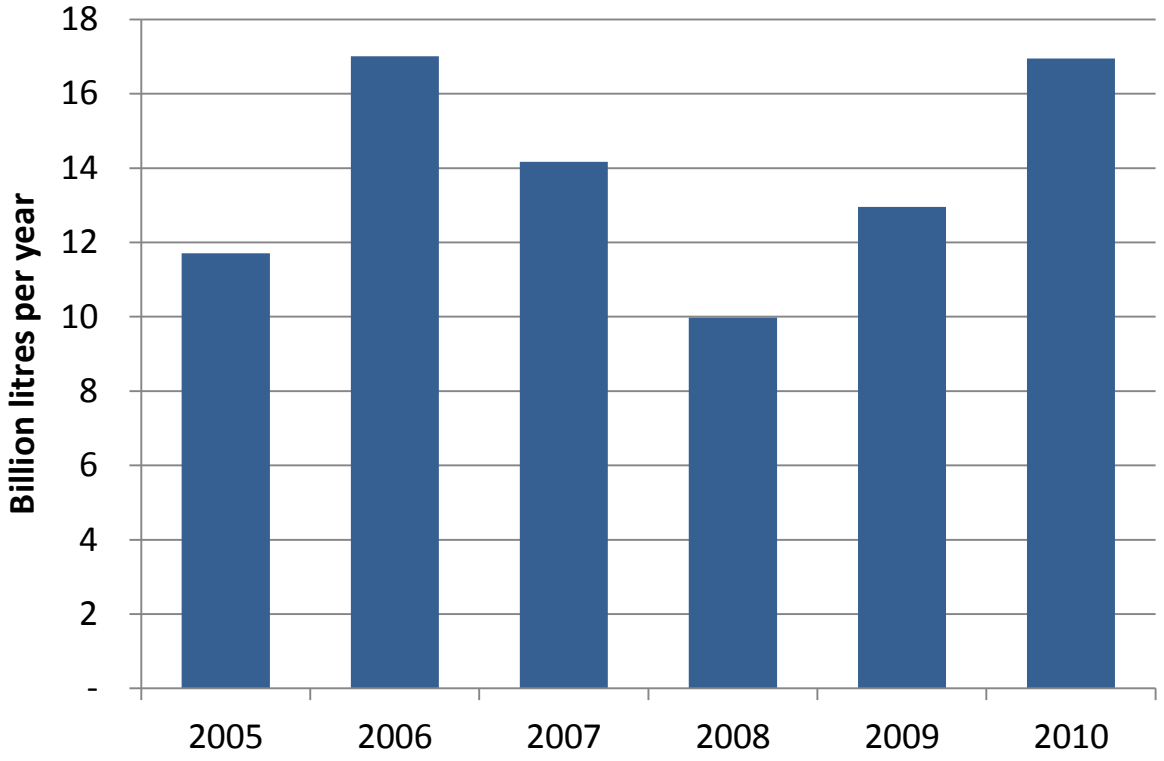


Source: ECI et al. (2013) for the ASC.
Notes: The left bar for each river basin region shows the area of each crop grown in 2000 and the right bar shows the area in 2010. The graph only shows the area under cultivation for the major crops listed.

- The majority of cropland in England is located in the south and east of the country, in areas already facing the highest levels of water stress. The south and east are also the areas likely to experience the largest reductions in summer rainfall due to climate change.
- While there has been a decline in cropped area between 2000 and 2010, there has been no significant trend in the spatial distribution of crops grown in climatically suitable locations.

1. Water demand by agriculture

Total volume of water abstracted for winter storage (on-farm reservoirs)	↔	On-farm storage reservoirs reduce pressure on water resources during summer months and provide additional reserves for farmers when water is scarce



Source: Cranfield University (2013) for the ASC.
Notes: Abstracted volumes are based on reported abstraction under winter storage licences. The capacity of on-farm reservoirs will almost certainly be greater than shown as not all reservoirs will have been empty and completely filled during the winter of each year.

- The total volume of water abstracted for winter storage has risen by an average of 4% per year between 2005 and 2010, although the volume abstracted in 2010 was not as high as it was in 2006.
- Between 2007 and 2013, grants were awarded for around 50 reservoirs under the Rural Development Payments for England scheme, totalling around 3.5 billion litres in capacity. This does not include reservoirs constructed without RDPE funding.

2. Flooding of agricultural land

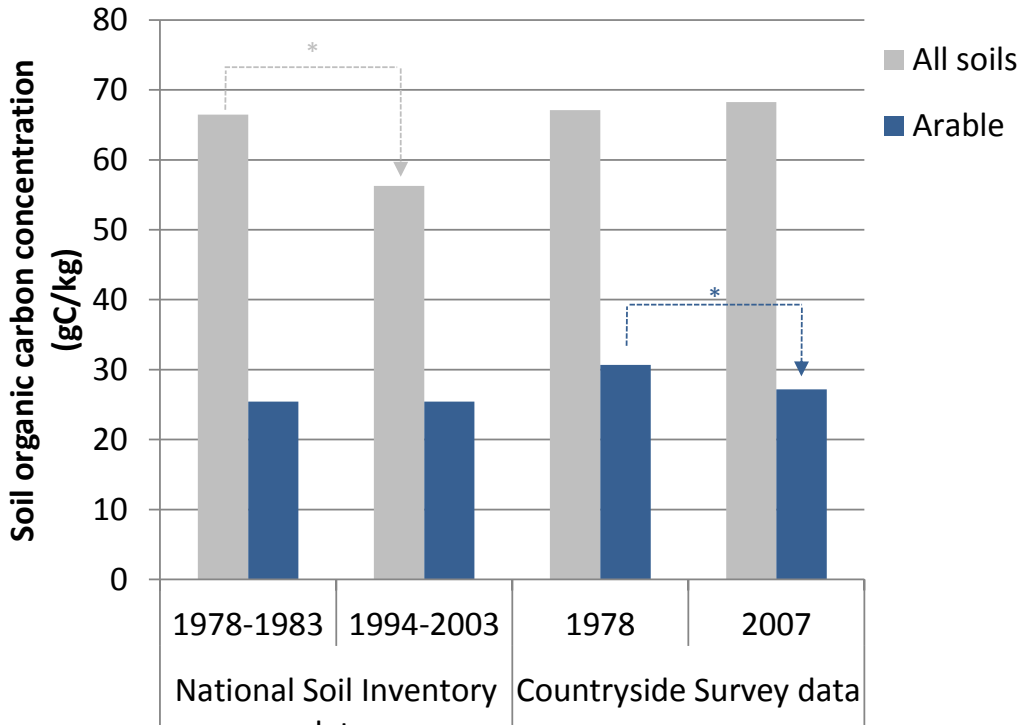
Measure	Data series	Source	Trend	Implication
No indicators with a sufficient time series have been identified for this adaptation priority. The ASC's assessment of progress being made in managing this adaptation priority has been based on snapshots of the actions taking place.				

3. Fertility of agricultural soils

Measure	Data series	Source	Trend	Implication
Total soil organic carbon in arable soils	1978 to 2007	National Soil Inventory and Countryside Survey	↓	Loss of soil organic matter reduces soil fertility and limits the ability of farmers to take advantage of future opportunities to increase production with climate change
Development of agricultural land	2001, 2008 and 2011	OS Mastermap / Agricultural Land Classification	↑	Development of agricultural land continues, which will constrain future UK food production
Area of land covered by high erosion risk crop types	1969 to 2010	EDiNA	↔	High risk crops can increase soil erosion, reduce soil fertility and may lead to some areas becoming unprofitable
Uptake of soil conservation measures on wheat fields (only)	1985 to 2010	Food and Environment Research Agency	↑	Higher uptake of soil conservation measures potentially reduces both soil erosion and losses of soil carbon

3. Fertility of agricultural soils

Total soil organic carbon in arable soils	↓	Loss of soil organic matter reduces soil fertility and limits the ability of farmers to take advantage of future opportunities to increase production with climate change

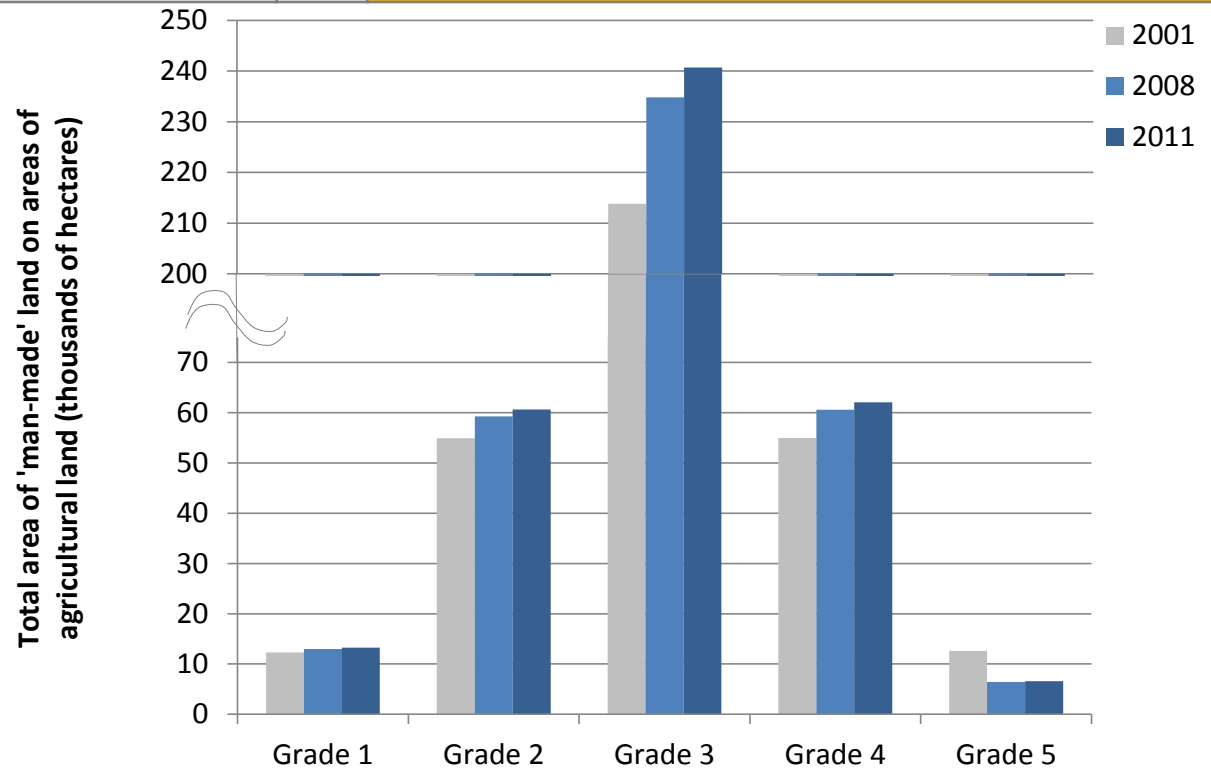


Source: National Soil Inventory (Cranfield University) and Countryside Survey (Centre for Ecology and Hydrology).
Notes: * denotes a statistically significant change over the period shown. Bellamy et al. (2005) based on the National Soil Inventory found significant changes in soil carbon in the richest arable soils (with carbon concentrations up to 200 grams per kilogram), but not across arable soils as a whole. It is important to note that there is a high degree of uncertainty around both estimates produced by the Nation Soil Inventory and the Countryside Survey.

- Both the National Soil Inventory (NSI) and Countryside Survey report a decline in soil organic carbon in arable soils. The NSI found losses of around 0.4 grams per kilogram each year between 1978-83 and 1994-2003. The Countryside Survey found losses of 3 grams per kilogram each year between 1978 and 2007.
- Trends in soil organic carbon in all soils are less certain. While the National Soil Inventory reports a fall of around 0.7 grams per kilogram each year in all soils, the Countryside Survey reports no significant change.

3. Fertility of agricultural soils

Development of agricultural land	↑	Development of agricultural land continues, which will constrain future UK food production

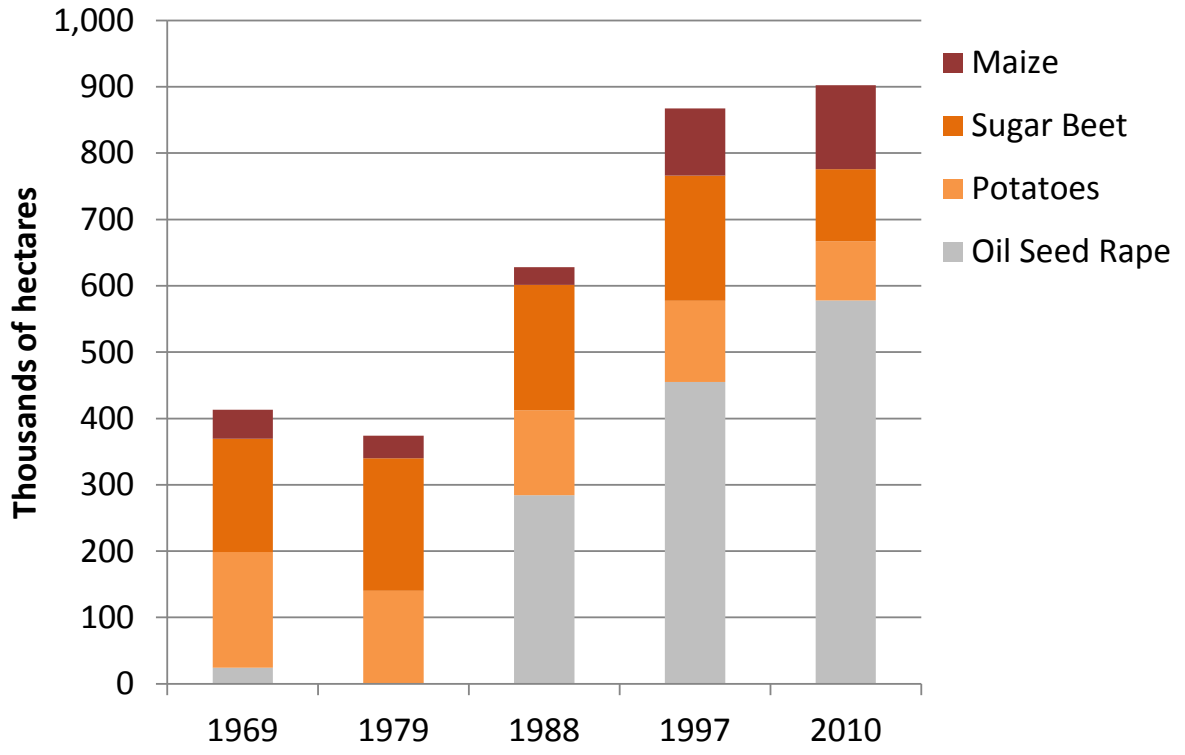


Source: ECI et al. (2013) for the ASC.
Notes: Estimates of the area of land lost to development have been calculated by overlaying the Ordinance Survey MasterMap and Agricultural Land Classification data available from the MAGIC database. The area represents the total footprint of the properties built on agricultural land.

- Around 800,000 properties were built on 35,000 hectares of agricultural land between 2000 and 2011.
- The majority of development was on Grade 3 land, accounting for 27,000 hectares of the total agricultural land developed between 2000 and 2011 (shown by the difference between the dark blue and grey bars for Grade 3 land).
- Only 0.2% of Grade 1 and 2 land was lost as a result of development between 2000 and 2011.

3. Fertility of agricultural soils

Area of land covered by high erosion risk crop types	↔	High risk crops can increase soil erosion, reduces soil fertility and may lead to some areas becoming unprofitable



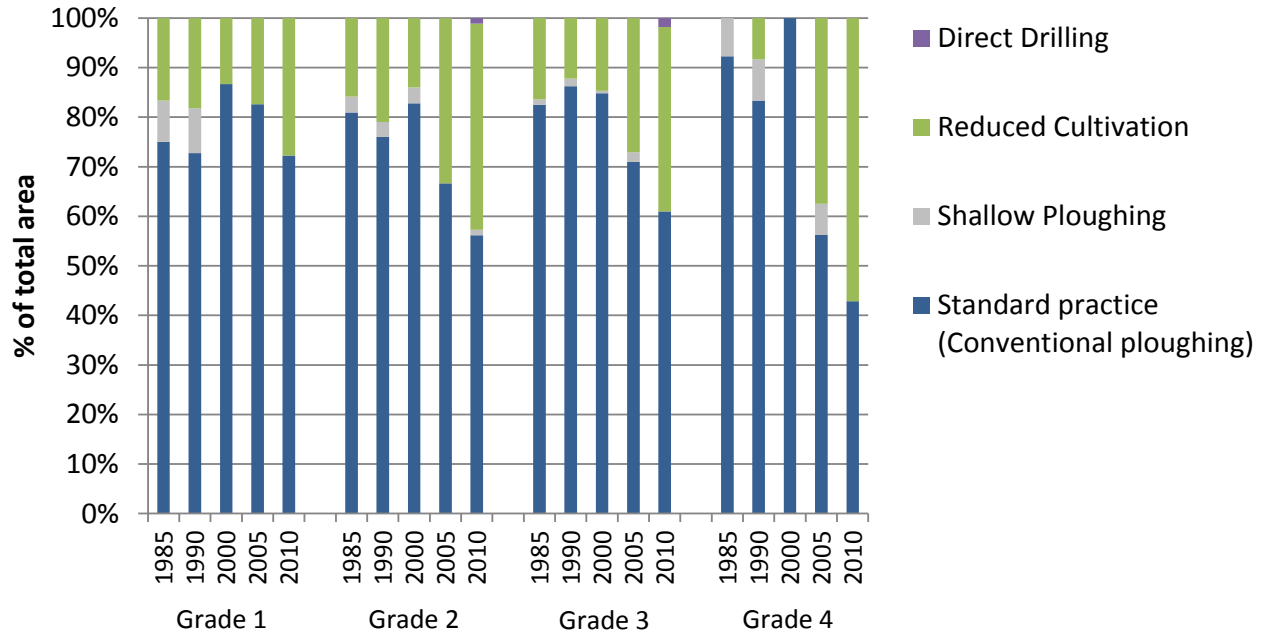
Source: June Agricultural Census.

Notes: This graph shows the changes over time in the area of agricultural land covered by selected high erosion risk crops (sugar beet, potatoes and maize) and low erosion risk crops (oil seed rape). This is based on data from the Edinburgh University Data Library (EDiNA) analysed in Cranfield University (2015) for the ASC. While based on the same survey, these figures differ slightly to the aggregate June Agricultural Census data published by Defra. This is partly because the EDiNA converts the data collected for each parish into data for each kilometre grid square of England to allow trends in crop types to be mapped spatially. No data were available for the area of oil seed rape under cultivation in 1979.

- The area of land covered by sugar beet and potatoes fell by around a third between 1988 and 2010. These are relatively high erosion risk crops. One field in ten of potatoes and one field in seven of sugar beet are at risk of erosion.
- The area of land covered by oil seed rape has increased. This is a relatively low erosion risk crop, with one field in 100 at risk of erosion.
- However, these trends have been partially offset by a five-fold rise in the area of land covered by maize between 1988 and 2010. Maize is a relatively high erosion risk crop.

3. Fertility of agricultural soils

Uptake of soil conservation measures on wheat fields (only)	↑	Higher uptake of soil conservation measures potentially reduces both soil erosion and losses of soil carbon



Average sample size	18	85	142	13

Source: Food and Environment Research Agency, presented in ASC (2013).
Notes: The data represent the responses to a farmer survey where farmers were asked which of four methods they were using. There are 1,553 records split over the five years. The Agricultural Land Classification (ALC) provides a framework for classifying land according to the extent to which its physical or chemical characteristics impose long- term limitations on agricultural use. Grade 1 is excellent; Grade 2 is very good quality; Grade 3 is good to moderate quality agricultural land; and Grade 4 is poor quality agricultural land. See ASC (2015) for detail on other soil conservation measures.

- There has been an increase in the uptake of minimum tillage practices across all grades of agricultural land cultivating wheat between 1985 and 2010. There has also been some uptake of shallow ploughing and deep drilling practices.
- Uptake of soil conservation measures is lower on Grade 1 land (the highest grade) than on other grades of land.

4. Climatic suitability of tree species

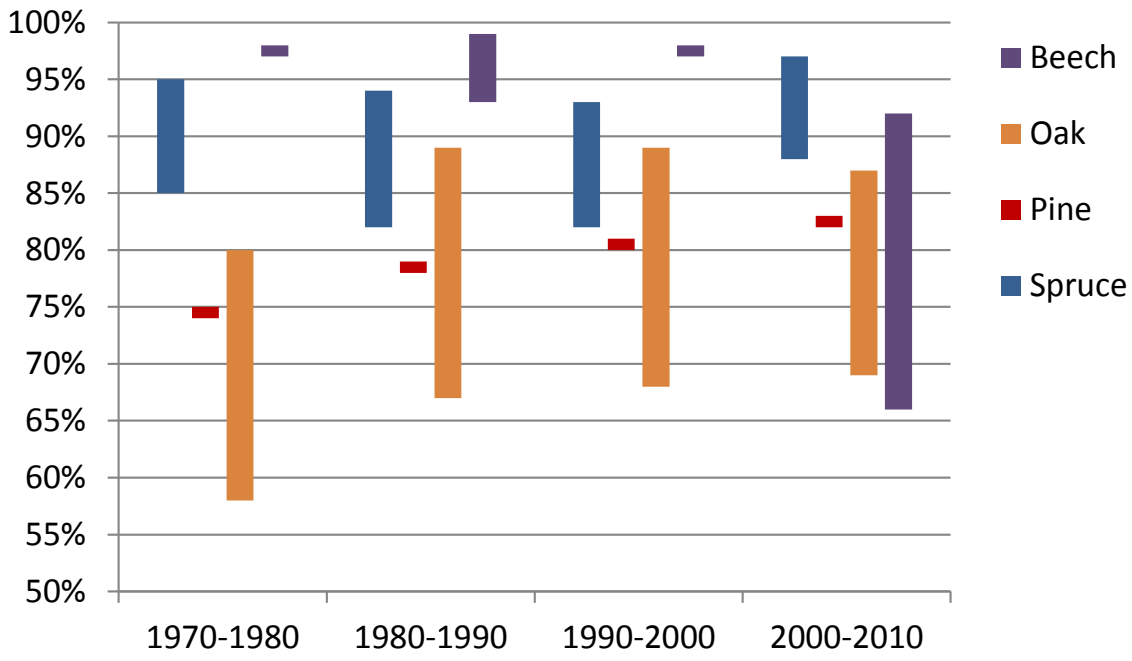
Measure	Data series	Source	Trend	Implication
Proportion of timber species planted in areas likely to be suitable in 2050	1970 to 2010	Forestry Commission	↑	Trees planted in suitable locations will be more resilient to climate change
Diversity of tree species delivered for planting by the Forestry Commission	2005/06 to 2013/14	Forestry Commission	↑	Greater diversity of tree stock provides insurance against a range of potential future climate scenarios and means woodland is more resilient to pests and diseases
Proportion of woodland in active management	2008 and 2011 to 2015	Forestry Commission	↑	Woodland in active management is likely to be more resilient to risks from climate change

4. Climatic suitability of tree species

Proportion of timber species planted in areas likely to be suitable in 2050

↑

Trees planted in suitable locations will be more resilient to climate change



Source: Forestry Commission.

Notes: Plots show the percentage of trees planted that are likely to be in climatically suitable areas in 2050, shown by decade when the trees were planted. Bar heights show the range that would be in suitable areas from a high to a low climate change scenario. Suitability is determined based on the Forestry Commission's Ecological Site Classification model, which considers how productive trees will become for timber in the future based on climatic factors including temperature, water availability, and biogeographical factors such as soil type. This data refers to trees planted by the Forestry Commission within the Public Forest Estate only. Definitions of the different categories of suitability: unsuitable = < 50% of maximum observed UK productivity, suitable = between 50 and 75%, very suitable = >75% of maximum productivity. Four site factors are climatic (see ASC (2013) for further detail).

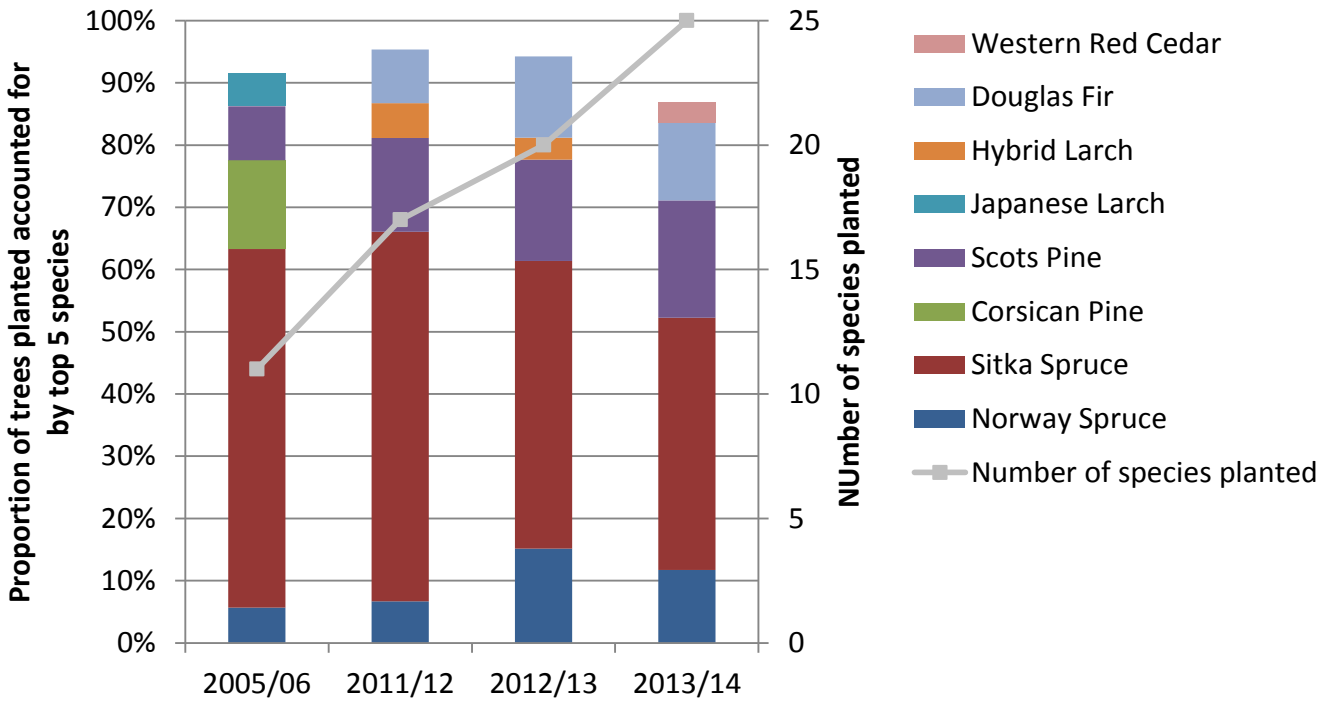
- Oak, pine and spruce species have been planted in progressively more suitable areas since 1970. For example, between 88% and 97% of spruce species planted between 2000 and 2010 are in areas likely to be suitable in the 2050s.
- Beech suitability declined between 2000 and 2010, with between 10% and 35% of planting sites between 2000 and 2010 becoming unsuitable by the 2050s. However, this trend may be skewed because of the very small area of beech planted since 2000 (only 10 hectares).

4. Climatic suitability of tree species

Diversity of tree species delivered for planting by the Forestry Commission

↑

Greater diversity of tree stock provides insurance against a range of potential future climate and means woodland is more resilient to pests and diseases

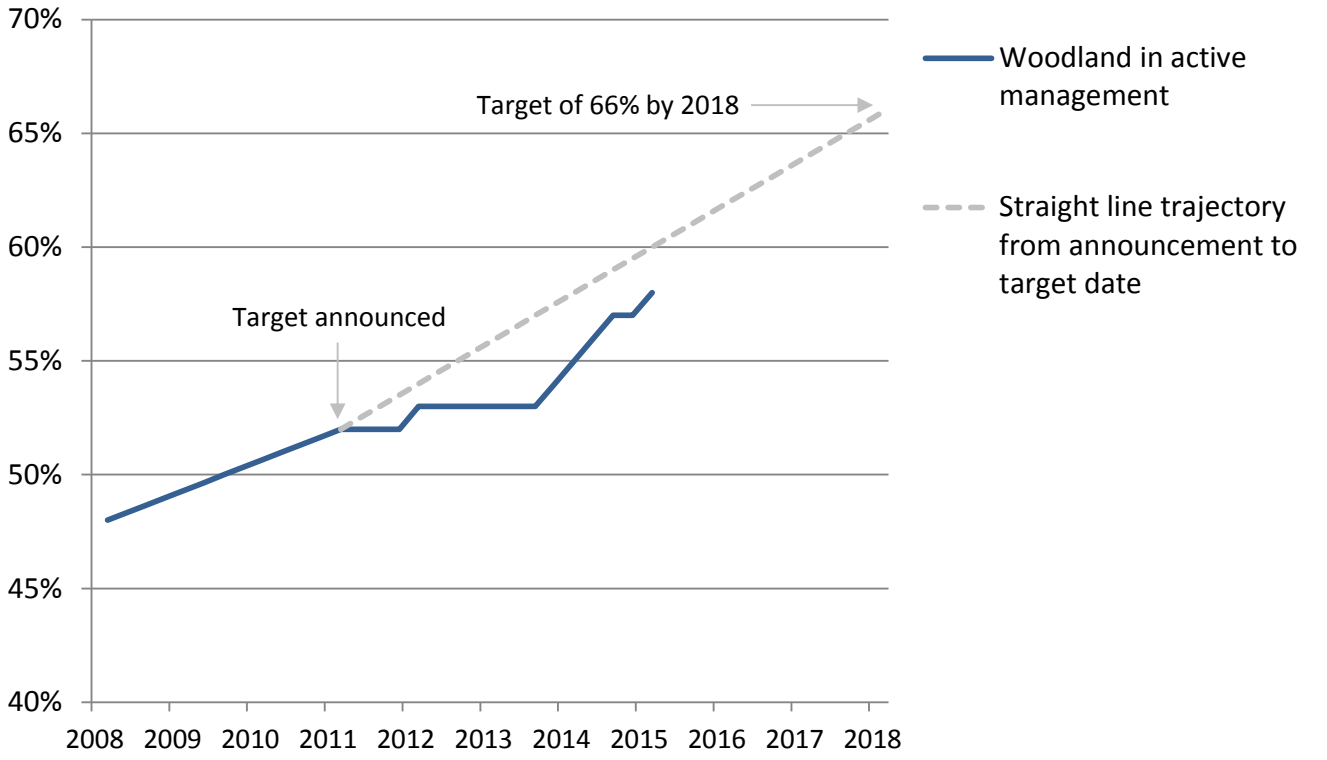


Source: Forestry Commission.
Notes: The top 5 species planted in a given year differ between years. This explains why there are more than five species shown in the bars.

- The number of different conifer species delivered for planting by the Forestry Commission on the Public Forest Estate increased from 11 in 2005/06 to 25 in 2013/14.
- The proportion of trees planted that were accounted for by the top 5 species in a given year has also fallen in recent years. In 2013/14, the top 5 species accounted for 87% of the trees delivered for planting compared to 91% in 2005/06.
- The planting of Corsican Pine ceased between 2005/06 and 2011/12 due to the moratorium caused by Red Band Needle Blight. This species has been replaced by Scots Pine.

4. Climatic suitability of tree species

Proportion of woodland in active management	↑	Woodland in active management is likely to be more resilient to risks from climate change



Source: Forestry Commission.
Notes: This indicator of woodland in management includes woodlands where there has been Forestry Commission England grant or felling licence activity typically in the previous 15 years – it is recognised that other woodlands might be considered as managed as well.

- In 2011 the Forestry Commission announced a target to increase the percentage of woodland in active management to 66% by 2018
- Since 2011 the proportion of woodland in active management has increased from 52% to 58%.

5. Prevalence of new and existing pests and diseases

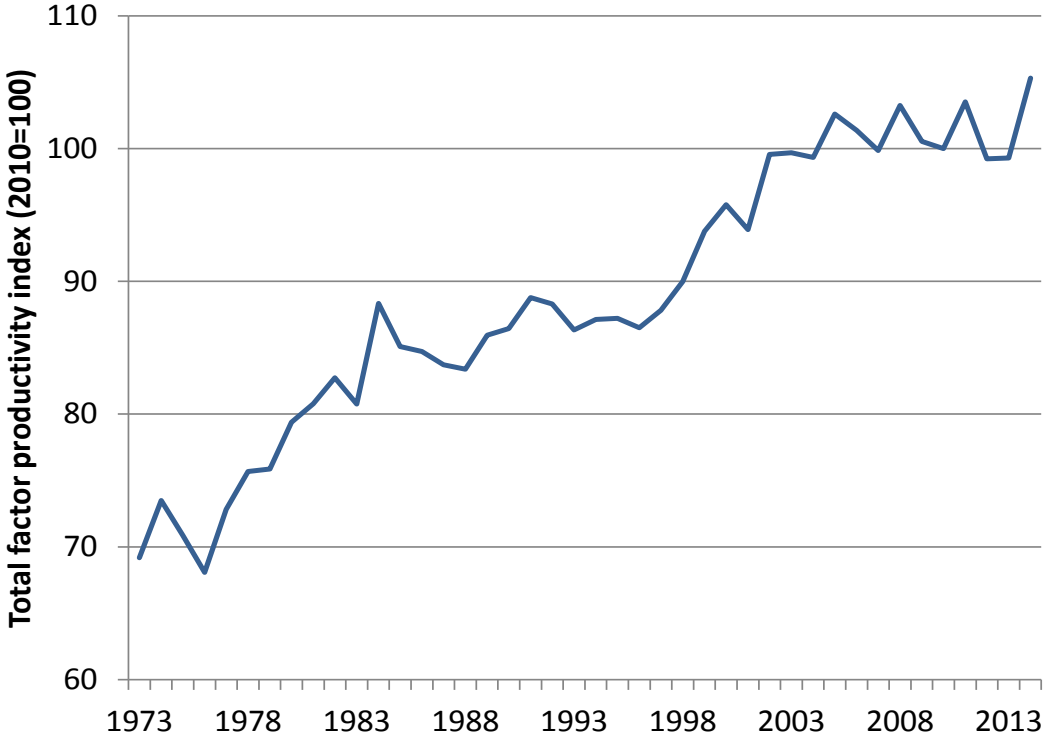
Measure	Data series	Source	Trend	Implication
No indicators with a sufficient time series have been identified for this adaptation priority. Data are collected by FERA (now part of Defra, Fera Science Limited and the Animal and Plant Health Agency) on the impacts of individual pests and pathogens. This is not currently brought together to calculate the total economic losses from pests and diseases. More evidence is also needed to show that climate change is driving part of the trend in past pest and disease incidence.				

6. Innovation and knowledge transfer

Measure	Data series	Source	Trend	Implication
Total factor productivity of UK agriculture	1973 to 2010	Defra	↔	The levelling-off in total factor productivity in recent years may indicate a decline in innovation and knowledge transfer to farmers
Research and development spend on agriculture	1987 to 2009	ONS and OECD	↓	A decline in R&D means there is likely to be less investment in the UK in the technologies and practices needed to maintain and increase UK food production in a changing climate

6. Innovation and knowledge transfer

Total factor productivity of UK agriculture	↔	The levelling-off in total factor productivity may indicate a decline in innovation and knowledge transfer to farmers

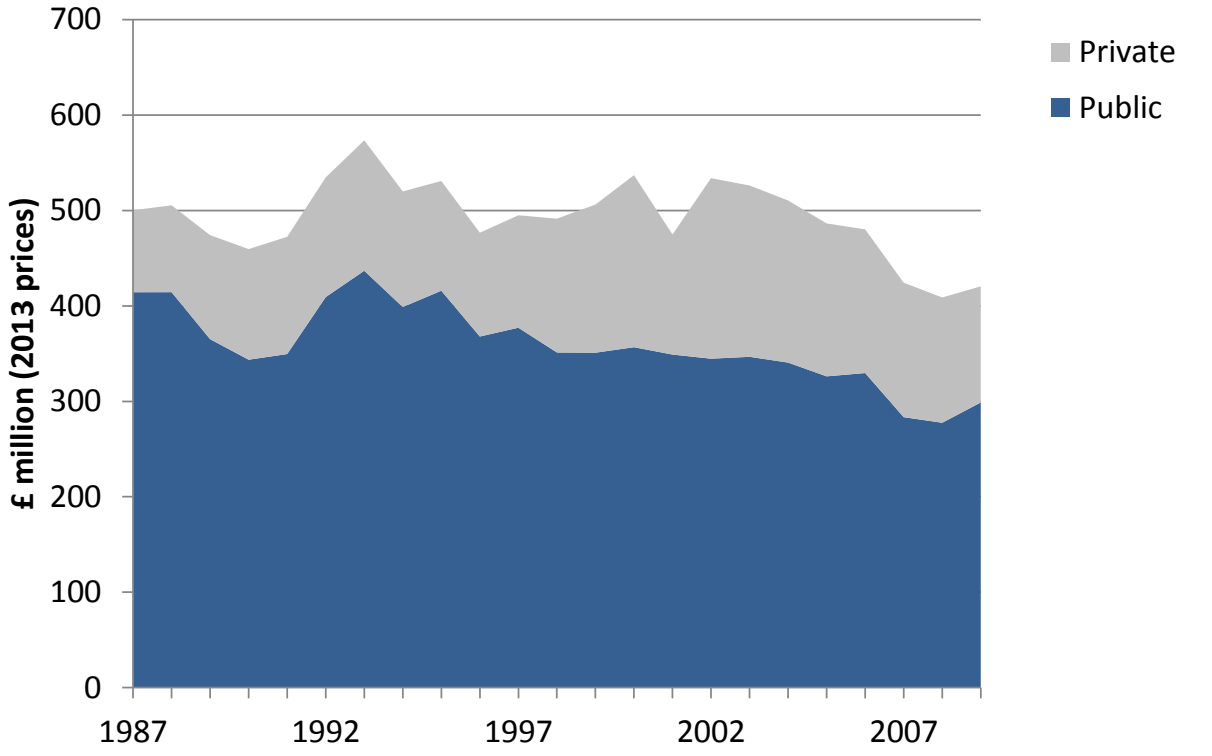


Source: Defra *Total factor productivity of the agriculture industry*
Notes: Total factor productivity is a measure of the efficiency of production. It is the growth in output which is unaccounted for by growth in inputs. Total factor productivity growth is generally driven by technological change, scale economies and switching to more productive agricultural activities.

- Total factor productivity rose steadily between 1973 and 2002, but growth has since slowed.
- The annual rate of increase between 1975 and 1984 was 1.68% per annum. Between 1985 and 2009 the rate slowed to 0.26% per annum. This increase was lower than in France, Italy, Germany and the US.

6. Innovation and knowledge transfer

Research and development spend on agriculture	↓	A decline in R&D means there is likely to be less investment in the UK in the technologies and practices needed to maintain and increase UK food production in a changing climate



Source: OECD.
Notes: R&D expenditure has been deflated using the GDP deflator published by the ONS.

- Overall research and development expenditure on agriculture fell by 16% in real terms between 1987 and 2009. This was driven largely by declines in public sector R&D spend. One impact of this decline is likely to be a slowing of the increase in agricultural efficiency.

Adaptation Sub-Committee

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