



# Executive Summary

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There is increasing evidence that global warming is caused by human activity: the release of greenhouse gases from burning fossil fuels, industrial processes and changes in land use. Of the man-made pollutants, carbon dioxide (CO<sub>2</sub>) is the principal greenhouse gas, but methane, nitrous oxide and industrial chemicals are also important. Developed countries agreed in Kyoto in December 1997 to reduce their total emissions of greenhouse gases by 5% by 2010 relative to 1990 levels. The agreed international target for the UK is 12.5%. It also has a domestic goal of reducing CO<sub>2</sub> emissions to 20% below 1990 levels by 2010.

The past decade in the UK has been the warmest in over 300 years, and 0.5°C warmer than the average 1961-90 climate. Warm winters have reduced the number of frosts; warm summers have included record hot spells and high sunshine totals.

The climate change is likely to continue:

- CO<sub>2</sub> concentrations will continue to rise, from around 360 ppmv (parts per million by volume) at present to 450-600 ppmv by the 2050s. CO<sub>2</sub> has beneficial effects on agriculture by encouraging photosynthesis and reducing transpiration.
- Globally, sea level will rise by 10-50 cm by the 2050s. In the UK, sinking land could exacerbate the effect in the east and south, while rising land would partly offset it in the north. Agriculture and settlements in low-lying areas could be affected by incursion of salt water into aquifers, coastal erosion and coastal flooding. If coastal storms become more intense and/or frequent the increase in combined risk of flooding could be significant.

- By the 2050s, the UK is likely to be about 1-2°C warmer than the present 1961-90 average. Winters are expected to warm more than summers. Hot spells, such as occurred in the 1995 summer would show a dramatic rise in frequency. Higher temperatures increase evaporation rates, reduce frost hazards and winter chilling, lengthen the growing season and accelerate plant growth. Heat stress may affect some crops.
- Changes in precipitation (rainfall and snowfall) are difficult to calculate, but average seasonal changes are expected to be relatively modest (increases or decreases of 10%), at least until the 2050s. More rainfall is expected to fall in intense events, however, increasing runoff and the risk of erosion. Precipitation patterns might also become more variable, resulting in greater probabilities of floods and droughts - but this is still very uncertain. The combination of higher temperatures and changed precipitation regimes has implications for water balances and organic content of soils, with consequences for irrigation demand and use.

The impact of climate change on arable crops, horticulture, weeds, pests and diseases, grasslands and livestock includes changes in the location of agricultural activities, earlier development and growth, changed yields and quality.

For arable crops, the overall effect on yield of increased CO<sub>2</sub> and temperature will be broadly neutral. Nutrient requirements will increase relatively little (perhaps 10%). The range of current crops will move northward and marginal crops such as maize may increasingly penetrate southern UK. New crop varieties, suitable for the changed climate, may need to be selected.



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Greater extremes of climate pose threats that are difficult to predict and adjust to but will, as now, have large effects. A rise in sea level will have local but agriculturally important impacts which may not be overcome easily by new crop varieties.

High quality **horticultural crops** will be more susceptible to changing conditions than arable crops. Field vegetables will be particularly affected by changes in temperature. Those species most likely to benefit commercially from higher temperatures are phaseolus bean, onion and sweetcorn. The availability of water is critical to the production of quality fruit and vegetables; a decrease in supplies will focus attention on increased efficiency of water use.

**Intensive grassland agriculture** will be affected by direct effects on grass yield and forage production and also indirectly by effects on other crops and their potential to provide economic and sustainable returns. The relative suitability for different types of **livestock** throughout the UK is unlikely to change significantly. Production systems involving ruminants at grass or in naturally ventilated housing are likely to adapt to the changes expected in the next 50 years. Intensive livestock (pigs and poultry) are at risk of increased heat stress. Thermal stress influences productivity and health. Disease transmission is likely to increase from greater exposure, e.g. from faster growth of pathogens in the environment and more efficient and abundant insect vectors. There may be consequences for food quality.

The potential for **soils** to support agriculture, and the future distribution of land use, will be strongly influenced by changes in the soil water balance. Where soil water deficits increase, crop productivity will suffer, and for some crops this is likely to result in the increased use of irrigation. Conversely, drier soil conditions may favour arable agriculture in the currently wetter regions of the UK as a result of improved soil workability, and diminished poaching risk in grassland areas. Soil organic matter levels will depend on the balance between carbon inputs to soils and the rate of loss resulting from decomposition.

**Weeds** evolve rapidly to overcome control measures. Very short-lived weeds and those that spread vegetatively (such as couch and creeping buttercup) evolve fastest. The rate of evolution will increase in hotter, drier conditions and in 'extreme' years. This increased rate of evolution could lead to some types of herbicide tolerance becoming more common.

Predicted climate changes are likely to increase the UK range of many native **pests and diseases** but decrease the range of others. Native species that are not currently economically important may become so, while the significance of other pests and diseases may diminish. Surveillance and eradication procedures for some alien pests (e.g. the Colorado beetle) and diseases are likely to become increasingly important.



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**Farm management** will be affected by climate change. Soils, climate, markets, technology, capital and policy all influence the location and type of farming. In determining future cropping in a warmer climate, it is extremely important to take into account increased climatic variability and the pattern of rainfall (amount, distribution and intensity). Unfortunately, these are the hardest features of climate change to predict. Increased climatic variability will require closer crop monitoring, scheduling of work peaks to ensure that crops are harvested and established in the appropriate conditions, and provision for greater fluctuations in markets and income.

Agriculture in the UK is highly adaptable, as demonstrated by improved technology, sustained output and profitability over the last 50 years. The impact of climate change depends on the mix of global effects on demand and production

and the local effects of warmer temperatures and altered growing conditions. The policy and economic framework for European agriculture could significantly mitigate the impact of climate change.

Significant uncertainties remain in our understanding of climate change, its impacts and the most effective responses.

**Nevertheless, farmers should consider three strategies:**

- maintain or enhance their ability to adapt to change;
- anticipate climate change in some decisions;
- take steps to reduce emissions of greenhouse gases.