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Global Food Security
Sustainable, healthy food for all







insight

Severe weather and UK food resilience

Overview

- Severe weather events are high impact, unusual or unseasonal changes in weather patterns and include droughts, heat-waves, floods and storms. These events and their consequences are likely to become more severe in the future.
- The UK experienced severe drought events in 2011 and early 2012, followed by a wet summer in 2012. Defra estimated that farm profitability fell between 2011 and 2012 by 14% (£737m).
- Effects of severe weather on food production can include a decline in crop yield or quality, animal death or stress and associated impact on production potential, effects on storage and transport logistics, damage to machinery and buildings and food price increases.
- Adaptation measures for the increasing variability in weather provide an opportunity to minimise potential losses, protect investments already made to on-site infrastructure and keep operations financially viable.
- Significant shocks to production as a result of severe weather are likely to negatively impact food security and have the potential to create price rises which may adversely affect consumers.
- Global Climate Models are currently being used to predict the future climate. Long term forecasting is an on-going research area, but the ability to predict sudden high impact weather events at a localised level is limited.
- Risks from severe weather and food insecurity are greatest in some of the most vulnerable areas of the world (i.e. Africa and South Asia). The UK is working through a number of international collaborations and partnerships to help mitigate impacts and adapt to changing weather patterns.
- Decision makers can use a number of tools to prepare for severe weather events, (such as scenario planning, using the 'potential pathways approach to adaptation' and using near term climate projections).

Global Food Security (GFS) is a multi-agency programme bringing together the main UK funders of research and training related to food. The GFS Insight series provides balanced analysis of food related research, for use by policy-makers and practitioners.

insight

What is severe weather?

Severe weather events are high impact, unusual or unseasonal changes in weather patterns, which include heavy precipitation, droughts, heat-waves, floods and storms. Our ability to predict the weather with any confidence for more than a few weeks is currently limited.[1] Severe weather events are likely to increase in the near future and pose an increasing threat to food security (see box 'Severe weather is becoming more frequent' for further detail). At the local level, the impacts of severe weather are also influenced by the landscape and how it is managed.

How does severe weather impact throughout the food supply chain?

Severe weather can impact upon the productivity of crops and livestock in many ways to reduce yields and/or quality. These losses can occur because, during sensitive stages of crop or animal development, critical physical and/or physiological thresholds are exceeded, or because key agronomic measures such as pest control and harvesting, cannot be carried out at the optimal time. Beyond the farm, severe weather can impact at all stages of food supply chains by disrupting logistics, storage, processing, packing and retail[2] and can have knock on effects on the wider farming system (i.e. at the catchment level). For example, given that approximately 90% of all our fresh fruit is imported[2], bad weather anywhere in the world could affect our supply chains. Some examples of supply chain impacts include:

- **A decline in crop yield amount or quality**, due to temperature extremes, water availability, flood damage[3] and soil condition affecting plant growth, harvesting and planting conditions[4,5]. The relative importance of temperature and precipitation changes on crop yield is changing due to a combination of management (e.g. irrigation use increase) and climate change.[6] Changes in land use away from the production of livestock feedstuffs may occur[7], affecting access to animal feed.
- **Animal health, welfare or productivity** is affected by changes in temperature, precipitation levels and seasonal patterns. The prevalence of parasites and disease in livestock can change.[7]
- **Storage and transport logistics** are affected by road, airport and sea port closures (e.g. heavy snow, high winds, flooding or fog). Transporting vulnerable animals (e.g. poultry, young chicks and piglets) during periods of high temperatures or very wet conditions may lead to greater mortality rates.[7] Many retailers and modern production systems rely on a steady flow of produce away from the farm. If this is disrupted, the build-up of produce on the farm can, within days, cause problems relating to space, animal welfare, quality control and the contamination of production lines.
- **Price increases** from collective impacts on food markets will affect access to food and animal feed for consumers and farmers.
- **Reactionary or panic measures** such as export bans, on the part of policy makers, or hoarding, on the part of consumers, can amplify the impacts of a shock on price and food availability. State intervention (e.g. restrictions on international trade) can exacerbate the problem of price volatility by isolating part of the market, thereby reducing the overall ability of the market to absorb supply shocks.[2]

The impact on food markets

The impact of severe weather events can lead to food shortages at a global scale. Within Europe, such shortages are likely to lead to price rises (price spikes), rather than food becoming unavailable. Poor and marginal households are particularly vulnerable to price spikes, because they already use a large proportion of their overall expenditure on food[8]. In some parts of the world food price spikes have reduced access to food and have been linked to civil unrest; in 2011 food price spikes occurred at the same time as violent protests in North Africa and the Middle East.[9]

The impact on UK farming

In England and Wales, agricultural production has recently been affected by high impact weather through a severe drought that was directly followed by a wet summer. The drought started with a dry winter in 2010-11, followed by a dry and unseasonably warm spring in 2011. A second dry winter in 2011-12 meant that many farmers were unable to fill their winter storage reservoirs and temporary bans were placed on public water supplies, because rivers and groundwater supplies were low.[2] A wet summer in 2012 resulted in flooding, leading to waterlogging, inability for machines to operate, low light intensities impeding growth, lack of pollination and increases in fungal diseases[2]. Some areas under water for the majority of the year.

In its farming statistics, Defra estimated that along with a fall in farm subsidies due a change in the £/€ rate, these combined weather events contributed towards a fall in farm profitability between 2011 and 2012 of 14% (£737m)[10]. Furthermore, provisional statistics for 2012 showed that overall harvest yields for cereals in the UK dropped from 7.0 tonnes per hectare in 2011 to 6.2 tonnes per hectare in 2012[11].

The livelihoods of farmers can be affected by severe weather in the UK and overseas, because of an increase in the uncertainty of factors such as seed quality, cost of inputs for crop and livestock systems, crop agronomy and livestock husbandry decision making as well as wholesale logistics of market supply.[12]

insight

The potential impacts of severe weather events on production are summarised in the table below (adapted from the Food Research Partnership (FRP) report '*Severe weather and UK food chain resilience*'[2]):

Weather Event	Mechanism of impact	Agricultural Impact
Heavy/extreme rainfall	– Affects pollination – Impedes access to land – Increasing disease risk – Waterlogging, reducing growth – Lodging of crops – Pesticide applications.	– Delayed agricultural activity – Reduced yields and quality – Increased costs (e.g. feed bills, for livestock kept indoors, drying costs for damp grain) – Potential increase in food waste due to reduced quality and impact of weather on consumer choice/or behaviour.
Flooding	– Impedes access to land – Erodes soil, washes away nitrogen and other inputs – Removes, drowns or lodges plants and seeds, leading to reduced emergence and growth – Compaction of soil – Death of livestock – Reduction in earthworm population[13].	– Long term yield or forage loss – Supply chain and transport impacts – Loss of livestock.
Extreme heat or drought	– Increased crop and animal stress – Heat stress e.g. pre-shearing in sheep – Reduction in forage, requiring supplementary feeding – High wear and tear on machinery – Shortage of irrigation water – Difficulty in optimising crop inputs – Hot still weather interacting with air pollution causes increases in ground level ozone, affecting plant metabolism e.g. wheat is sensitive.	– Lost yield and quality – Increased costs.
High wind	– Lodging in crops – Loss of leaves, blossom or fruit – Closure of UK sea ports and airports – Impacts on farm buildings, fences or hedges.	– Lost yield – Interruption of UK supply chain – Increased repair bills.
Snow, frost or hail	– Access to forage for livestock causing condition loss, abortion, death – Frost damage – Crop damage or death.	– Lost yield – Supply chain and transport impacts.

Severe weather is becoming more frequent

Recent research has suggested that global weather patterns are becoming more variable when considered from a historical perspective,[13] with the clustering of weather events becoming more common.[14] This is because both the average values and variability of climate are changing, leading to a shift in the distribution of weather events.[13]

Global Climate Models (GCMs) are currently being used to investigate future weather patterns and potential risks. However, these models have a limited capacity to account for extreme events or impacts, because they have a coarse spatial resolution and large uncertainty in their outputs.[15] Despite an increasing ability of GCMs to model the present-day climate successfully, the latest generation of GCMs still have difficulties reproducing daily precipitation and temperature.[16] Current research is underway to develop higher resolution models for improved, more localised seasonal forecasts, climate change projections and the prediction of severe weather events.[17,18]

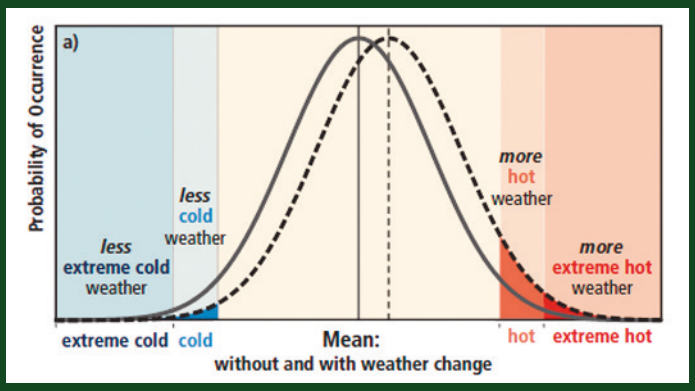

Figure 1: Extreme weather events are those which are rare and occur at the tails of the distribution.[1] In the above example,[19] temperature extremes (i.e. very hot or very cold) are demonstrated as being rare. But a small rise in the average temperature through greenhouse warming (right hand curve) can radically increase the frequency of hot extremes, whilst decreasing the frequency of cold.

How can we adapt to severe weather ?

Planning for future severe weather events

The impact of a severe weather event is determined by the nature of the event itself (e.g. its severity and geographical extent) and the response that is taken. To prepare for future severe weather events, further work is needed on planning for severe weather extremes in the near term.[2] In the FRP report on *'Severe weather and UK food chain resilience'*, the following research areas were recommended to enable planning[2]:

- **Forecasting extremes** at the seasonal to decadal scale. Extreme events are challenging for climate models to predict and are currently far from reliable, however improvements in extreme event prediction are currently underway.[20] Forecasting may be used to assess impacts and develop adaptation strategies.[21]
- **Scenario planning** can be used to mitigate the effect of extreme weather events by: 1) managing simultaneous impacts (e.g. concurrent drought and excess rainfall in UK production); 2) informing farmer adaptation strategies; 3) challenging the food industry on how to manage severe weather events with widespread impacts e.g. the 2012 floods and worse; 4) modelling the economic impacts of widespread disruption to a range of commodities simultaneously, in order to generate adaptation strategies.[2]
- **Adaptation strategies** using the 'potential pathways based approaches' to adaptation,[22] are conceptual frameworks for adaptation planning which articulate the risks, objectives, constraints and options for decisions on adaptation, enabling decision makers to identify appropriate adaptation strategies.

Improving society's resilience to severe weather events

The Public Weather Service, run by the UK Met Office, provides weather information and severe weather warnings to the public, businesses, emergency services and Government.[23] The **Environment Agency** also provides advice for farmers in extreme weather conditions on their website[24].

Globally, it has been recognised that there is a need to improve the accessibility, quality and usefulness of climate services and **The Global Framework for Climate Services** has been developed, under the leadership of several United Nations agencies.[25, 26] Within Europe, a four year project, **EUPORIAS** (European Provision Of Regional Impacts Assessment on Seasonal and decadal timescales) has been commissioned, to develop prototype climate services at seasonal to decadal timescales, which are relevant to decision makers and specific sectors (e.g. Food Security, Transport, Water, Energy, Transport etc.).[27]

insight

Mitigating severe weather risks on the farm

Adaptation practices on the farm can include using better short term predictions to inform decisions, investing in infrastructure to enable operation in times of stress and diversification of farming practice to spread risks. Financial support can also be provided to encourage mitigation and adaptation on the farm. Price support by the state (e.g. the Common Agriculture Policy (CAP) direct payment scheme), can provide stability for farming businesses at times when income and direct payments are reducing.[12, 28]

Innovative solutions and R&D will play a role in developing capacity to cope with extremes in weather.[29] For example, in the Defra report *'Climate change and extreme weather events'*,[15] on farm measures to adapt to extreme weather scenarios have been identified and are represented in the table below. Additional information from other sources has been added relating to the effects on farms of heavy precipitation, particularly snow.[30,31] Not all of these measures will be applicable on all farms, because they often require additional investment (the cost of which needs to be considered alongside any potential risk).

An overview at a national level of potential risks from extreme weather events can be found in *'The UK Climate Change Risk Assessment 2012. Evidence Report'*.[3]

	Flooding	Drought	Extreme high temperature and drought	Severe late spring frost	Heavy precipitation (rain, hail, snow)
Arable	– Changing the timing of spring and autumn cultivation and harvest.	– Increasing water storage.	– Increasing water storage and more tolerant varieties.	– Changing the timing of spring and autumn cultivation and harvest, applying more fungicide and carrying out fleecing.	– Better field drainage. – Resilient varieties.
Horticulture	– Building additional drainage capacity, using crop covers and raising beds.	– Increasing water storage, using irrigation, using crop covers, planting fruit crops later and spreading suppliers.	– Using and investing in novel irrigation methods for increasing the efficiency of irrigation. – Improving hygiene and using bio-control to regulate pests and using venting tunnels.	– Fleecing, using frost blasters, spreading, and better weather forecasting.	– Fleecing. – Better drainage. – Improving glasshouse and poly-tunnel design.
Dairy	– Maintaining tracks, housing animals and using temporary fencing.	– Growing new or a greater variety of food crops and improving animal housing design.	– Providing more shade for livestock (e.g. planting trees) and improving water accessibility for livestock.	– Altering the housing turnout date.	– Altering the housing turnout date. – Improving building design. – Increasing feed and bedding stocks.
Cattle and Sheep	– Buffering feed over the summer, moving grazing areas and housing animals.	– Buffer feeding over the summer.	– Increasing water storage and creating in-field shelters.	– Altering lambing date.	– Provision of additional feeding. – Moving grazing areas and housing animals. – Increased feed and bedding stocks.
Pigs	– Building additional manure storage, housing animals, keeping straw in reserve, keeping sows on high ground, separating slurry and water, moving huts and increasing the indoor area by building new huts.	– Inspecting and mending leaks in pipes and tanks. – Upgrading units to plastic pipes.	– Improving insulation and ventilation, providing mud wallows and upgrading the water delivery system.	– Improving insulation and ventilation and stockpiling straw.	– Improving building design. – Increased feed and bedding stocks.
Poultry	– Housing animals, upgrading access. – Improving insulation and ventilation. – Placing wooden slatted areas outside to help clean feet.	– Improving insulation and ventilation.	– Improving insulation and ventilation. – Reducing stocking numbers.	– Improving insulation and ventilation.	– Improving building design. – Increasing feed and bedding stocks.

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This review has been prepared by the science writer for the GFS programme, Theresa Meacham, and provides a representation of the current state of knowledge in a particular area. The review will help to inform policy and practice, which is based on a wide variety of factors, including evidence from research. The review does not necessarily reflect the policy positions of individual partners.

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