Our food systems are increasingly complex, interconnected and subject to a wide array of shocks and stresses. Shocks include food safety scares, such as the 2017 Fipronil eggs contamination incident in Europe, geo-political tensions between major importing/exporting nations for agricultural commodities and extreme weather events. Stresses come from natural resource degradation and changes in demography and climate.

The impacts of shocks and stresses might be severe or minor, depending on which parts of the food system are affected and to what extent, and are influenced by the responses of the affected actors and the outcomes of their activities. Not all food system actors will experience a shock or stress in the same way or to the same degree – some may benefit, while others may struggle. Nonetheless, the unprecedented systemic shock from COVID-19 has accelerated further scientific, policy and societal interest in the need to enhance food system resilience. While increasing food system sustainability in relation to social, economic and environmental parameters remain important, there is an increasing awareness across the sector that recognising and responding to shocks and stresses is key in managing future food system activities and hence outcomes. The food system that supports our economies and brings food to our plates needs to be more resilient and practitioners and policy makers in the UK and beyond are working to establish how this can be achieved.

Key questions
Food systems include all of the activities, people and processes related to producing, processing, wholesaling, retailing, consuming and disposing of food, and the associated logistics. They also include the outcomes of these activities for food security and other social, economic and environmental conditions. ‘Food systems thinking’ helps to see how the actors, their activities (the ‘what we do’) and the outcomes of their activities (the ‘what we get’) interact in time and space. This then allows for an assessment of who the winners and losers are for any given intervention and what impact this has. It also helps in structuring discussions on how to enhance resilience. These need to start by being clear on the specific issue and framing discussions around answers to

Maddy Diment, Saher Hasnain and John Ingram of the Environmental Change Institute, University of Oxford, describe a study to evaluate resilience strategies for the food systems of eight different countries by surveying the opinions of food system actors and identifying approaches to resilience highlighted in the literature.

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four key questions addressing resilience:
(i) of what – what needs to be enhanced (e.g. market gardening, food retailing)
(ii) to what – specifies the shocks and stresses that seek to destabilise the system (e.g. insect outbreaks, IT failures, etc.)
(iii) for whom – clarifies the interested groups (e.g. hospitality workers)
(iv) over what time (daily, seasonal, annual, etc.) defines the time frame.

It is important to have answers to all these questions as this sets the stage for the next consideration: how to enhance food system resilience.

Three notions of resilience

Most policy, practice and societal discussions focus on food system outcomes relating to food supply, other socio-economic goals (e.g. livelihoods and equity) and environmental conditions. Emphasis is normally placed upon enhancing the notions of robustness and/or recovery:

Robustness – aims to resist disruption to existing food system outcomes (i.e. maintenance of the status quo; e.g. keep the supermarket shelves well stocked all year round),

Recovery – aims to return to pre-existing food system outcomes after disruption (i.e. bounce back to the status quo, e.g. restock the shelves as quickly as possible).

There is, however, a third notion: Reorientation – which is about accepting alternative ('transformed') food system outcomes before or after disruption (i.e. bounce forward, reject the status quo, e.g. accept more seasonal produce and 'wonky veg'). This is based on the premise that 'reorienting' societal expectations of food system outcomes can enhance food system resilience by making the outcomes inherently less vulnerable to shocks and stresses.

Employing any of these three strategies will involve:

Reorganisation – which means adapting food system activities. This is achieved by changing the policy, economic, social and/or technological ‘drivers’ that influence how different food system actors undertake their respective activities.

Identifying resilience strategies

Resilience-enhancing strategies need to be guided by answers to the four key questions and the level of ambition for outcome-transformation determines the degree of activity adaptation needed (e.g. consuming more seasonal produce); substantial transformation generally requires substantial adaptation. Answers to the four key questions, and hence the debate about how to implement any or a combination of the three resilience notions, will have major relevance to food system policy, practice and societal attitudes for food system futures.

Thus motivated, the UK has invested in a major research programme on the ‘Resilience of the UK Food Systems in a Global Context’[1], a £14.5m, five-year research programme, which was launched in 2016 by the Global Food Security Programme (GFS), the UK’s cross government programme on food security research. To date 13 projects have been funded, which have already provided a wealth of evidence on how different parts of the food system can be enhanced and have generated considerable interest in how other countries with
similar socioeconomic conditions are addressing the ‘resilience’ issue. To this end, the TempAg Programme, an international collaborative research network established in 2015 with support from the OECD (Organisation for Economic Co-operation and Development) Global Science Forum to increase the impact of agricultural research in the world’s temperate regions, commissioned a short project to research resilience strategies across its member countries: Belgium, France, Germany, Netherlands, New Zealand, Norway, Sweden, Switzerland and UK.

Methodology
A twin-track approach was adopted. The first approach invited representatives from each of the major food system ‘activities’ (producing, processing, packaging, transporting, wholesaling, retailing, catering and disposing) to answer the four key questions and to comment on what strategies they were instigating to enhance the resilience of their activity. As far as possible ‘umbrella’ organisations that represented specific activity groups were contacted, rather than individual companies. The aim was to establish a well-balanced foundation of ‘who’s doing what’, rather than a particular company’s approach. Representatives from national governments and civil society organisations were also invited to respond from their respective policy viewpoints.

The second approach involved an online search of reports and associated material using a wide range of search terms. This was designed to try to establish the degree to which different countries were working on how to enhance food system resilience. In total, 87 documents were identified, 74 of which were included within the literature review. The documents were first classified by type: webpage, report, academic paper, academic report, policy brief and academic book (Figure 1). They were then coded according to spatial resolution. For example, the document discussing food system resilience in Bristol was spatially coded as ‘City’, whereas, a document discussing global food system resilience but featuring a TempAg country as a case study was coded ‘Global’. Most documents addressed the national level (Figure 2). The documents were also assigned a star rating based on their relevance to the resilience agenda (Figure 3).

Survey responses
Due to several compounding factors including COVID-19 and Brexit, there was a very limited response to the survey. Of the six survey responses received, three were from Switzerland and three from the UK; they represented the following actor groups: national government, civil society, catering/hospitality, packaging and waste disposal. These responses did, however, provide an insight into the activities and challenges within the food system.

Resilience of what?
Responses to this question were imprecise. Several just remarked that the entire food system needed to be ‘more’ resilient. The range of specificity amongst responses illustrates the challenge of articulating a clear ‘goal’:
‘Everyone is doing their own thing’ (catering chain, UK)
‘The entire food system’ (national government body, Switzerland).

Resilience to what?
Answers to this question had recurrent themes within some clear groupings:
- Environmental change: ‘reducing unsustainable food production’ (consumer body, Switzerland)
- Food sector pandemics: ‘bird flu, African swine flu’ (hospitality association, UK)
- Economic and financial pressures: ‘increased wealth in emerging countries means demand outstrips supply of protein’ (hospitality association, UK)
- Market/supply chain issues: ‘supply chain failure’ (catering chain, UK).

The response from a UK waste organisation elaborated further upon the interrelated nature
of shocks and stresses within the food system that result in changing market demand: ‘Shocks to production from adverse weather, gluts of food production, changes in demand for food e.g. related to export markets and changes to imports e.g. Brexit, pandemics, contamination of food, disease in the supply chain, deliberate adulteration, strikes in logistics or waste.’

Resilience for whom? Answers to this question were, again, varied suggesting a range of viewpoints regarding who the food system actors are: ‘The broader public, since almost everybody constantly consumes chemicals that are derived from food packaging.’ (packaging association, Switzerland)

‘The whole supply chain, from farmers to retailers and hospitality and food service sectors.’ (waste association, UK)

‘Consumers, politicians, food entrepreneurs and professionals in the food production and distribution industry.’ (consumer body, Switzerland).

Resilience over what timeframe? Most responses considered resilience on a mid/long term scale (1-5 years). One response noted the need to consider multiple timeframes simultaneously:

‘Some of the shocks can cause a rapid growth (i.e. in days) in waste e.g. after COVID-19 or a food safety event or disruption to trade. Some can have a longer timeframe (2-3 weeks to deal with a particularly good harvest of a vegetable). Building in capacity and resilience will take time (for recycling plants there might be a 1-3 year lead in time for plants to be operational)’ (waste association, UK).

Literature review Five resilience attributes were identified in one of the documents:

- General self-efficacy
- Willingness to change
- Focus of control
- Social sense-making
- Strategic thinking focus

These were complemented by seven principles important for building and strengthening resilience:

1. Maintain diversity and redundancy
2. Manage connectivity
3. Manage slow changes and feedback
4. Foster complexity and systems thinking
5. Encourage learning
6. Broaden participation
7. Promote polycentric governance

Causes for decreased resilience capacity included having ‘dependence on foreign countries, the absence of economic and ecological diversity and of actors in the agricultural world’ and a ‘lack of insight into food companies’ resilience’.

Approaches to increase resilience capacity were multifarious. Notably, local initiatives and sustainable principles in business play an important role in improving resilience of food systems. New technology was also identified as an important contributor: one survey of 40 companies in the UK food supply sector found that 63% of participants believed that an autonomous robotic force will improve resilience of supply chains and 27% said big data analytics are a priority to improve overall resilience. However, the use of ‘biotechnology cannot, by itself, increase the UK’s domestic food supply, but it can be one of the tools used to ensure better resilience in the UK food chain, and to reduce environmental damage’.

Recommendations A wide range of recommendations were identified within the literature, with key examples including:

- Adapt food system activities. Promote increased diversity in crops and landscapes to strengthen the resilience of regional food systems.
- Change patterns of consumption.
- Adapt food system drivers that influence and shape the decisions and behaviours of the actors in the food system.
- Change food production policies, initiate policy discussion about agri-environment schemes, introduce new trade regulations and build consumer awareness on healthy eating patterns.
- Create a ‘territorial food resilience policy’ that can be applied at both the national and European scale, which prioritises solidarity-based food security, taking into account the most vulnerable populations, farmers and the environment.
- Support the creation of business tools for food system resilience.
- Create a regulatory environment that fosters partnerships and diversity.
- Develop an open spatial data infrastructure.
- Create a food and drink sector strategy.
- Fund training and skills development.
- Extend food enterprise zones to support health outcomes.
- Champion international agreement on dietary advice.
- Use public procurement to drive the health and sustainability agenda.

Adapt ‘worldviews’ of what we want from food systems, for instance:

- Take a systems-based approach and integrate positive actions to enhance resilience with multiple goals – such as health, employment, food security etc.
- Collaborate with other partners (e.g. NGOs, international organisations, etc.) who are working towards food system resilience, e.g. create resource centres, offer mentoring schemes (e.g. professional pro bono services).

Some recommendations were specific to the UK:

Conclusions Analysis across the TempAg countries finds that despite increasing recognition of the importance of enhancing resilience, the terms ‘resilience’ and ‘sustainability’ are often used interchangeably. This suggests that while resilience is emerging in academic and policy debate, it has yet to penetrate the often specialised and compartmentalised set of food system actors. Further, while a discussion on the need for enhanced resilience was evident in the literature, very few documents offered practical methods for achieving it. It is also clear that there is a need to identify and analyse more thoroughly the range of temporal levels at which food system resilience needs to be considered. As such, a more proactive, coordinated and evidence-based approach to risk management and resilience building is required to maintain societal resilience and sustainability in the face of the complex risks we are facing domestically and globally.

Reduce reliance on EU imports
- Currency hedging
- Retain EU migrant employees
- Forward buying logistics capacity.