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Resilient Fresh Produce Supply Chains

Written by:

Amy Stoner NSch

July 2025

A NUFFIELD FARMING SCHOLARSHIPS REPORT

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Date of report: July 2025

NUFFIELD Farming Scholarships

"Leading positive change in agriculture. Inspiring passion and potential in people."

Title	Resilient Fresh Produce Supply Chains
Scholar	Amy Stoner
Sponsor	The Food Chain Scholarship
Objectives of Study Tour	**1.** Understand the challenges facing fresh produce supply chains. **2.** Gather attitudes from key stakeholders (growers, manufacturers, retailers, policy and industry experts). **3.** Develop solutions to enhance the resilience of fresh produce supply chains in the UK.
Countries Visited	UK, Germany, Brazil, Chile, Netherlands, Poland, Italy, Kenya, Senegal, Spain, Belgium, Japan
Messages	• All businesses should strive to be 'business reimagined' by rethinking their operations with adaptability and flexibility at the core - Investing in readiness and ensuring both efficiency and long-term resilience at every stage of the supply chain**.** • All stakeholders within the supply chain need to continuously adapt to the unknown challenges faced through climate change, logistic and geopolitical issues, economic and labour pressures and consumer demands, in an ever-changing world. • All stakeholders must take shared responsibility to influence and lead change across the supply chain. • All stakeholders in the fresh produce supply chain should adopt the four-step approach, which was developed following my Nuffield Study Tour (this approach can also be adopted for other food supply chains). The steps are: (1) resilience risk assessment and contingency planning, (2) key actions by stakeholders, (3) transformation, and (4) future planning. • Adopting this approach across the supply chain through small, incremental changes is my final recommendation to ensure a more resilient fresh produce supply chain in the UK.

EXECUTIVE SUMMARY

Fresh produce supply chains are facing an increasing number of challenges impacting UK produce security. This was highlighted in April 2023 in the UK, when there were fruit and vegetable shortages across all major retailers; this also impacted food manufacturers, resulting in product recipes having to be amended at short notice, to maintain supply. These shocks are becoming more frequent and impactful as the challenges to the supply chain increase.

The objectives of my Nuffield study tour were to (1) understand the challenges facing fresh produce supply chains, (2) gather attitudes from key stakeholders (growers, manufacturers, retailers, policy and industry experts) on what they believe needs to change and how we can influence change, and (3) develop solutions to enhance the resilience of fresh produce supply chains in the UK.

Resilience is the ability to adapt and remain flexible, while lean manufacturing focuses on optimising efficiency. However, these principles can mean different things at various stages of the supply chain. The key to successfully combining resilience with lean practices lies in operational flexibility. To achieve this, businesses must strive to be 'businesses reimagined', rethinking their operations with adaptability and flexibility at the core. This means investing in readiness and ensuring both efficiency and long-term resilience at every stage of the supply chain.

The challenges impacting fresh produce supply chains include climate change, logistical and geopolitical issues, economic and labour pressures and changing consumer demands. But it's evident the biggest issue is the unpredictability, not knowing what challenge will impact the supply chain next.

All stakeholders must take shared responsibility to influence and lead change across the supply chain by continuously adapting, ensuring the long-term resilience of the UK's fresh produce sector. Businesses visited throughout my travels that were the most resilient were able to adapt and be more flexible, meaning they are more prepared for future challenges.

Building a resilient fresh produce supply chain requires a fundamental shift in how we think and operate (mindset change). All stakeholders in the fresh produce supply chain should adopt the four-step approach, which was developed following my Nuffield study tour (this approach can also be adapted to other food supply chains). The steps are: (1) resilience risk assessment and contingency planning, (2) key actions by stakeholders, (3) transformation, and (4) future planning. Adopting this approach across the supply chain through small, incremental changes is my final recommendation to ensure a more resilient fresh produce supply chain in the UK.

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CHAPTER 1: INTRODUCTION

Figure 1: The author, Amy Stoner [Source: Author's own]

I grew up in rural Oxfordshire, but now live in Rutland with my partner Dan. We have a small sheep flock and an allotment, which keeps us busy outside of work.

I have always been passionate about food and farming - setting up my own business running children's cookery parties and participating in my local Young Farmers' Club, getting involved in Young Farmers' cookery competitions. This led me to study Food Nutrition and Wellbeing (BSc) and Food Industry Management (MSc) at Harper Adams University.

After graduating from university in 2019 I went to Australia. I worked on an arable farm for seeding and harvest, a cattle station and a winery in Western Australia.

I returned to the UK in 2021 after being offered a job with Samworth Brothers, a leading UK food manufacturing business producing quality chilled, ambient, own label and branded foods for the major UK retailers, where I work as Compliance and Raw Materials Manger. Throughout my time at Samworth Brothers I have expanded my knowledge of the UK food system and its reliance on the global supply chain. These insights have allowed me to understand the vulnerability of a system which is built on 'Just in Time' processes from farm to fork, that can be easily disrupted.

Fresh produce (specifically lettuce, tomatoes and cucumbers) are integral raw materials in our business. The heavy reliance on fresh produce, coupled with the ever-increasing vulnerability of their supply chains, has led me to want to take a forward-thinking approach, investigating how we can ensure resilient fresh produce supply chains in the UK.

CHAPTER 2: BACKGROUND TO MY STUDY SUBJECT

Food security is the constant availability of food in a country. Having reliable access to nutritious, affordable, and safe food, whilst ensuring a resilient supply chain in the face of global challenges such as climate change, pandemics, conflict, and politics (Environment, Food and Rural Affairs Committee, 2023).

Global supply chains are tightly interwoven systems designed for maximum efficiency, especially in fresh produce, where perishable products demand just-in-time delivery. Consumers have come to expect access to any food, anytime, but this convenience masks how reliant we are on fragile logistics. Orders are often finalised late in the day, and operations run hand to mouth, with little room for disruption. This is particularly important as the UK imports around £61.4 billion of food each year (£13.2 billion of which is fruit and vegetables) (Figure 2).

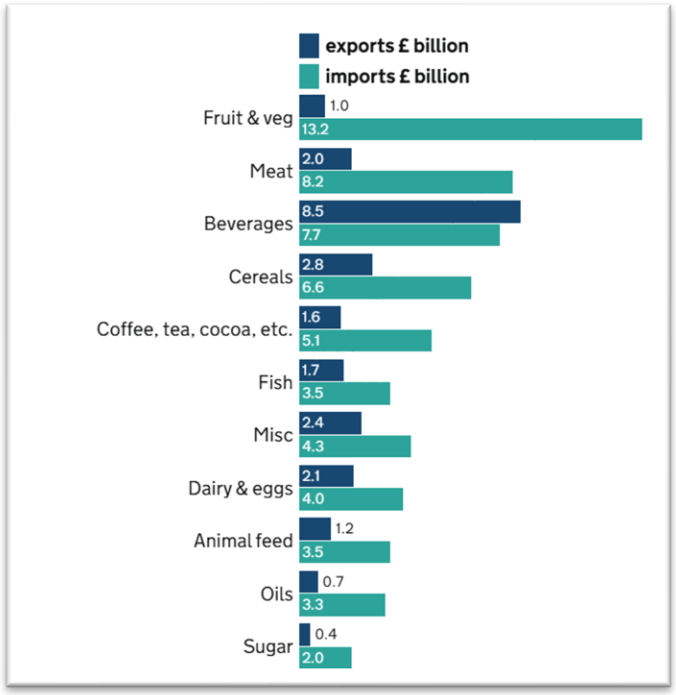

Figure 2 - UK Trade in Different Food Groups in 2023 [Source: DEFRA, 2025]

Fresh produce supply chains are facing an increasing number of challenges impacting UK produce security. This was highlighted in April 2023 in the UK, when there were fruit and vegetable shortages across all major retailers, this also impacted food manufacturers, resulting in product recipes having to be amended at short notice, to maintain supply. These shocks are becoming more frequent and impactful as the challenges to the supply chain increase.

Whilst there is a need to move to resilient practices, it is not inherently embedded in current systems. In fact, rigid frameworks such as approved supplier lists and

strict product specifications can reduce flexibility and hinder the ability to respond to shocks. The key challenge is finding ways to integrate resilience alongside efficiency (e.g. lean manufacturing) without significantly increasing production costs.

As part of the next generation of leaders in the food industry, I want to ensure that food manufacturers have improved resilience, with an active strategy for supply management and security. This would ensure the supply of fresh produce, to continue to make healthy, nutritious food for our customers.

CHAPTER 3: MY STUDY TOUR

I visited the UK, Germany, Brazil, Chile, the Netherlands, Poland, Italy, Kenya, Senegal, Spain, Belgium and Japan during my study tour (visits detailed in Appendix 1). I chose to visit countries that are known for technological advancements and innovation (Japan) and have a large export market for fresh produce. A large proportion of fresh produce exported to the UK is grown in Senegal, Spain, the Netherlands, and Kenya, making these countries key for my study tour.

3.1 Interview methodology

Semi-structured interviews were undertaken with 41 stakeholders around the world and across the supply chain (growers, food manufacturers, retailers, policy makers and 'others' including industry experts and academics, who work or are involved in the horticulture sector, to gather key stakeholder opinions. They were appropriate to interview due to their level of knowledge and expertise in the produce sector. Respondents were determined by connecting to individuals and businesses in each country who were willing to be interviewed. All stakeholders were asked the same set of questions (Appendix 2).

Table 1 - Stakeholders interviewed

Stakeholders	**Total Number of Semi-Structured Interviews**
Growers	24
Manufacturers	4
Retailers	2
Policy	2
Other (Industry Experts & Academics)	9
Total	**41**

CHAPTER 4: CHALLENGES FACING FRESH PRODUCE SUPPLY CHAINS

There is no denying that fresh produce supply chains are facing an increasing number of challenges. But what are they? Working for a food manufacturing company I often only see one side – supplier shortages and last-minute firefighting to find supply. Therefore, I wanted to use this opportunity to speak to stakeholders in the supply chain and to understand some of the challenges that face other stakeholders in the supply chain.

4.1 Climate Change

The changing climate will lead to rising temperatures resulting in drought and water shortages, flooding and adverse weather conditions, impacting food production globally (Hasnain, 2024). Every single person I spoke to on my Nuffield travels mentioned climate change when asked what the biggest challenges are facing fresh produce supply chains. Research by Ripple *et al.* (2024) has shown unpredictability and extreme changes to climate are going to be the biggest challenges.

Case Study 1 – Rising Temperatures

West Africa Farms, Senegal Managing Director, Robin Mann said he had seen temperatures rise to 46°C during summer 2024, the highest he had ever seen it. This is subsequently causing complex chemical reactions in the soil +40°C which they need to adapt to (Figure 3).

Figure 3 - Spring onion harvest, West Africa Farms, Senegal [Source: Author's own]

Case Study 2 - Flooding

I arrived in the Murcia Region of Spain a week after the Valencia floods in November 2024. Although the floods did not affect the Murcia region, they still had 35mm of rain in one field overnight (Figure 4), the average is 30mm of rain for the month of November (Climates to Travel, 2025).

Figure 4 - Celery field, Mucia Region, Spain [Source: Author's own]

4.2 Logistics and Geopolitical Issues

Fresh produce supply chains are inherently complex, involving perishable products with a short shelf life and numerous stakeholders, meaning they can be impacted by transport disruptions and trade barriers at any time. Unlike other traded goods, delays in fresh produce shipments often lead to significant food waste and lost income for businesses due to short shelf-life products. These challenges are heightened by geopolitical tensions, affecting supply routes.

Case Study 3 – Avocado Exporting Logistics, Kenya

The war in the Middle East means shipping lines are choosing to re-route their vessels around the cape of Africa, avoiding the Red Sea and Suez Canal to reach Europe, increasing freight time by 10-14 days (Baraniuk, C., 2024). In Kenya, I met Richard from Kakuzi PLC. who said due to the Red Sea crisis it can take 42-45 days transit from Kenya to EU by boat, resulting in produce quality challenges and additional costs (Figure 5).

Figure 5 - Avocado Packhouse, Kakuzi PLC, Kenya [Source: Author's own]

4.3 Economic and Labour Pressures

The fresh produce industry is experiencing economic pressure due to the costs of inputs increasing. Table 2 shows over two years (2022 – 2024) in the UK, energy costs have risen 218%, fertiliser is up 47% and labour costs are up by 24% which is squeezing margins for growers (NFU, 2024). Stakeholders commented on the rising input costs which are impacting businesses around the world.

Table 2 - Cost price inflation (left table) and cost of production increases (right table)

Product	2022	2023	Total compound cost
Tomatoes	+27%	+10.3%	38.5%
Lettuce	+20%	+11.2%	33.4%
Mushrooms	+17%	+11.4%	30.3%
Strawberries	+20%	+10.3%	32.3%
Potatoes	+20%	+6.6%	27.9%
Broccoli	+25%	+5.6%	32%
Onions	+21%	+6%	28.2%
Carrots	+20%	+8%	29.6%
Apples	+23%	+9.3%	34.4%

Source: Promar International, based on B2B interviews

Product	2022	2023	Total compound cost
Labour	+13%	+10%	24.3%
Energy	+165%	+20%	218%
Raw materials	+20%	+11%	33.2%
Seeds	+8%	+10%	18.8%
Fertiliser	+40%	+5%	47%
Ag chem	+18%	+13%	33.3%
Transport	+28%	+6%	35.6%
Diesel	+50%	-12%	32%
Packaging	+23%	+2%	25.6%

Source: Promar International, based on B2B interviews

(Source: NFU, 2024)

Although these input costs are going up in the UK, margins are still tight for growers and manufacturers, as inflation costs are not always passed down the supply chain (Searle, F., 2023). This is putting a lot of UK businesses in an unsustainable position, making it harder to reinvest, which is resulting in a consolidation of growers (due to smaller growers closing). I would argue this is not very resilient for the UK, as if something goes wrong (e.g. disease outbreak), we have a reduced pool of growers to source from.

Furthermore, the economic pressures are exacerbated by labour shortages which is a recurring issue impacting productivity around the world. Growers and manufacturers struggle to find seasonal and permanent workers, particularly during harvest. However, the noticeable difference when travelling to farms around the world was the number of employees. In the UK, it is often a struggle to find workers; many people do not want to do manual labour. It is also costly to pay pickers. For example, the average UK minimum wage increased to £12.21 per hour in April 2025 which equates to £1,953.6 per month based on a 40-hour week (GOV.UK, 2025)). Whereas in Kenya and Senegal I often saw more employees on the farm, as the cost of labour is cheaper compared to Europe (average minimum wage £88 per month in Kenya (Bizna Team, 2025).

Case Study: Labour Challenge at West Africa Farms, Senegal

Interestingly, another labour challenge in Senegal is people often only work two days a week when they need to get food from the local market to cook. There are also lots of weddings, funerals and baby naming ceremonies which can last up to

seven days, meaning labour fluctuates massively. Thus, posing a considerable challenge for employers who rely on a predictable workforce (Figure 6).

Figure 6 – The author at West Africa Farms with Robin and Gloris, Senegal [Source: Author's own]

4.4 Regulatory and Consumer Demands

In the UK we have developed our food system to have everything on the supermarket shelf all year round. The difference between the UK and Europe is the UK has a fixed pricing system for produce, compared to Europe where they have supply and demand pricing, with many EU retailers not allowed to sell produce for less than the cost of production (Searle, F., 2023). By comparison, the UK fixed pricing model could be seen to devalue produce, with an expectation that it is always available and therefore many consumers do not understand the seasonality of food production.

When speaking to growers around the UK there was a re-occurring theme that "*UK produce is too cheap*" for the end consumer, due to the economic and labour pressures that growers are facing not being passed on. In contrast, it's not just food inflation impacting the end consumer, but also the cost-of-living crisis, which makes it harder for the retailers to increase their prices. In 2025 food inflation is forecasted to rise 2.4%– 4.9%, and in July 2025 food businesses are also anticipated to experience higher import costs due to post Brexit border changes being implemented, which will mean more checks on fruits and vegetables entering the UK from EU. It is likely the food sector will only be able to absorb 20-40% of these costs, meaning the rest will have to be passed onto the end consumer (Davey, J., 2024).

Furthermore, the demand for affordable food in the UK is resulting in more produce being imported, not only from the Netherlands and Spain, but further away including Morocco and Egypt. This causes challenges because these countries have different growing standards compared to the UK.

From the regulatory side, it is important to note there are an increasing number of standards to comply with, as well as pesticide reduction plans (Maximum Residue Levels (MRLs) for chemicals in food) around the world, which is a challenge growers need to adapt to (Department for Environment, Food & Rural Affairs, 2025).

CHAPTER 5: RESILIENCE

5.1 Defining Resilience

Oxford English Dictionary definition: *"The capacity to recover quickly from difficulties; toughness."* (Oxford University Press, 2025).

Resilience seems to be a buzz word that everyone is using, so I wanted to find out if everyone within the supply chain is on the same page. Throughout my study tour I asked all stakeholders how they define fresh produce resilience. Figure 7 shows 66% of respondents (all stakeholders) across the supply chain defined resilience as the ability to 'adapt' and be 'flexible'. 24% of respondents (growers, retail, policy and other) defined resilience as 'availability'.

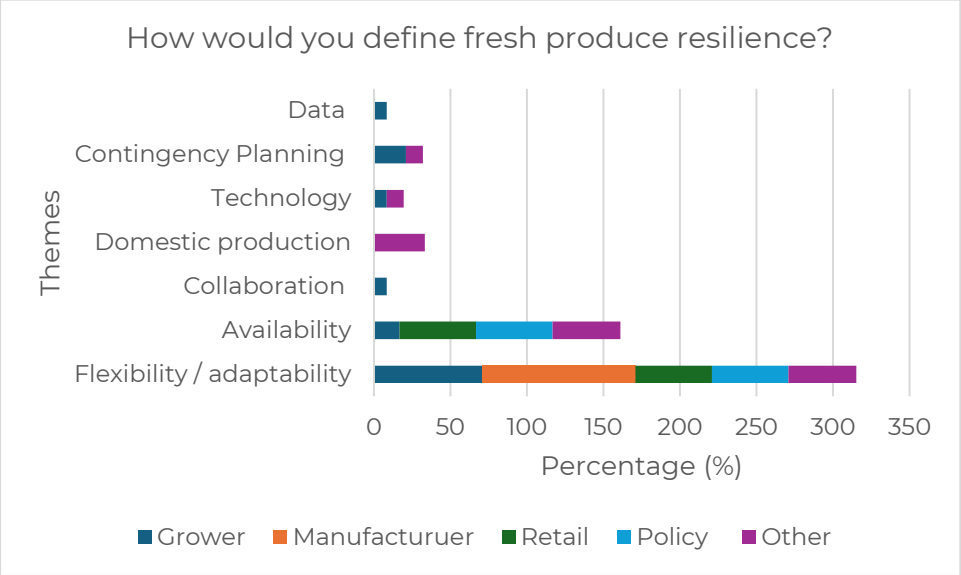

Figure 7- Defining fresh produce resilience [Source: Author's own]

Several definitions of resilience from interviews with stakeholders across the supply chain, are identified below.

Syngenta, The Netherlands, said resilience is *"The beginning of the supply chain (e.g. seed producers) needs to be the most resilient. The further down the supply chain you go (e.g. retail) resilience looks different, as you have alternative options"* (Figure 8).

Figure 8 – The author and Harry Winslet (2024 NSch) at Syngenta, Netherlands [Source: Author's own]

Chris Flowers (Managing Director at Kakuzi PLC, Kenya) said *"Control what you can control. You cannot control when it will rain or what the temperatures will be. Therefore, our business needs to be able to adapt to these challenges"* (Figure 9).

Figure 9 - The author with Chris and Sarah Flowers, Kakuzi PLC, Kenya [Source: Author's own]

A vegetable processor, Chile, said resilience for processors is *"we need to adapt to both ends of the supply chain – growers and retailers"*.

A retailer produce sourcing manager, UK, said resilience is *"The focus is on ensuring consistent availability and supply of these key fresh produce items, even in the face of disruptions"*.

Policy advisor, UK: *"Build as much of a buffer around your supply chain as you can, to make sure if one bolt comes loose, the whole show doesn't fall apart"*.

These examples show that across the different stages of the supply chain, resilience (the ability to adapt and be flexible) means different things for each business. For example, growers need to grow their crops to sell to their customers. They are adapting by spreading the risk with where they are planting and, in some cases, using regenerative farming practices. However, retailers' resilience is measured by maintaining a 98.5% service level, and they are adapting by diversifying supply sources. Ultimately, every business in the supply chain must remain profitable to survive, but the way they achieve this differs. This, I believe, is one reason why there can appear to be a disconnect across the supply chain, because resilience means different things to different people in the supply chain.

Speaking to Louise Manning (2007 NSch and academic) she said that from previous work and her own research (Shadbolt *et al.,* 2017) "*Resilience can be defined in three ways:*

1. *Business as usual – No change*
2. *Bounce without breaking (survival) – Learning from experience*
3. *Business reimagined – Transformation"*

In an ideal world, businesses should re-visit supply chain challenges (even those that do not directly impact your business) and look at how you can grow and reimagine your business so that the challenge doesn't impact you in the future, or if it does with less intensity. On my travels, the businesses I visited that were the most resilient were able to adapt and be more flexible (case study examples from my travels in Chapters 6-7), meaning they are more likely to survive supply chain shocks. All businesses should strive to be 'business reimagined' to invest in readiness and build long-term resilience, at every stage of the supply chain.

5.2 Resilient and Lean Manufacturing Principles

During my study tour I visited Japan, where I had the opportunity to visit Toyota - the home of continuous improvement and lean manufacturing. Although this may seem like a detour from my focus on fresh produce supply chains, it was there that I began to wonder: In the UK, we've developed a lean manufacturing system built around just-in-time principles. While lean manufacturing is known for its efficiency, it also makes businesses highly vulnerable to disruptions due to its reliance on these just-in-time principles (Touriki *et al.,* 2021).

Figure 10 - Toyota Manufacturing Visit, Nagoya, Japan [Source: Author's own]

When challenges arise in fresh produce supply chains (discussed in chapter 4), this could result in a business being unable to meet demand, if they were not prepared. Therefore, businesses need to understand where inventory can remain lean, and where there needs to be a buffer, as resilient manufacturing encourages having some buffers in your supply chain operation (which could add additional costs) (Banker, S., 2021, Kowalska *et al.,* 2023).

The question is, can our current lean manufacturing systems coexist with resilience? The answer is yes!

The key to combining these two approaches lies in operational flexibility. While lean manufacturing optimises efficiency, operational resilience ensures companies can adapt and recover quickly from unexpected challenges. Building resilience requires an upfront investment of time and resources, but the long-term economic impact of inaction will outweigh these initial costs. One way to illustrate this is by calculating the cost of lost sales (factoring in damage to consumer confidence and brand reputation) if resilience plans are not in place. For example, food manufacturers should understand where their vulnerabilities are, such as being single sourced on certain raw materials, to determine how much income they would lose if these key raw materials became unavailable for a week, month or even longer. Therefore, *"Operational flexibility is the missing link",* bridging the gap between lean and resilient principles (Kroupenev, A., 2022).

5.3 Resilience and Sustainability

Sustainability is defined; "*to be capable of enduring*" (Oxford English Dictionary, 2024), whilst minimising environmental impact & conserving resources (Mead & Hunt, 2023) - a term often used interchangeably with resilience.

In my research, 20% of respondents (growers, retail, policy and industry experts) identified sustainability as an area for change over the next 5-10 years to ensure a

more resilient fresh produce supply chain (e.g. moving towards regenerative farming practices). It is positive that four out of five stakeholders have sustainability on their agenda, most likely due to policies and incentives for businesses to focus on climate action and achieve net-zero carbon emissions by 2050 (United Nations, 2024).

It could be argued that a business cannot achieve true sustainability without first establishing the ability to adapt to and recover from challenges. Without resilience, efforts to meet environmental, social, and economic sustainability objectives are unlikely to succeed. Resilience, therefore, should be recognised as a critical foundation and prioritised within strategic business planning. I would argue, a truly sustainable business is often the most resilient (and vice versa).

In Brussels, I was fortunate to secure visits at the EU Consulate (Figure 11), where I met EU policy advisors. The EU ETS system was set up in 2005 and requires polluters to pay for their greenhouse gas (GHG) emissions, which is based on a "cap and trade" principle. The cap is the set limit of total GHG emissions that can be emitted by industries within the scope (currently aviation, maritime transport and industrial manufacturing), which is reduced annually in line with the EU's climate targets. However, it is important to note that from 2027, a new and separate European Union Emissions Trading System (ETS) will be introduced for other industries which could impact all stakeholders within fresh produce supply chain (European Commission, 2025), as the UK could adopt the same approach which is something businesses should be mindful of when progressing both sustainability and resilience plans in future.

Figure 11 - The author at the EU Consulate, Brussels [Source: Author's own]

CHAPTER 6: KEY STAKEHOLDER OPINIONS

6.1 Identifying the WHAT and the HOW for change

It's evident with the number of challenges facing produce supply chains, something needs to change. Therefore, I wanted to find out **WHAT** stakeholders in the supply chain believe needs to change and **HOW** we can make and influence change over the next five to 10 years, to help create a more resilient fresh produce supply chain. In my research, the **WHAT** defines the desired outcomes that key stakeholders have identified (as summarised in figure 12), while the **HOW** outlines the strategies and actions necessary to achieve these outcomes, with case study examples from my Nuffield study tour.

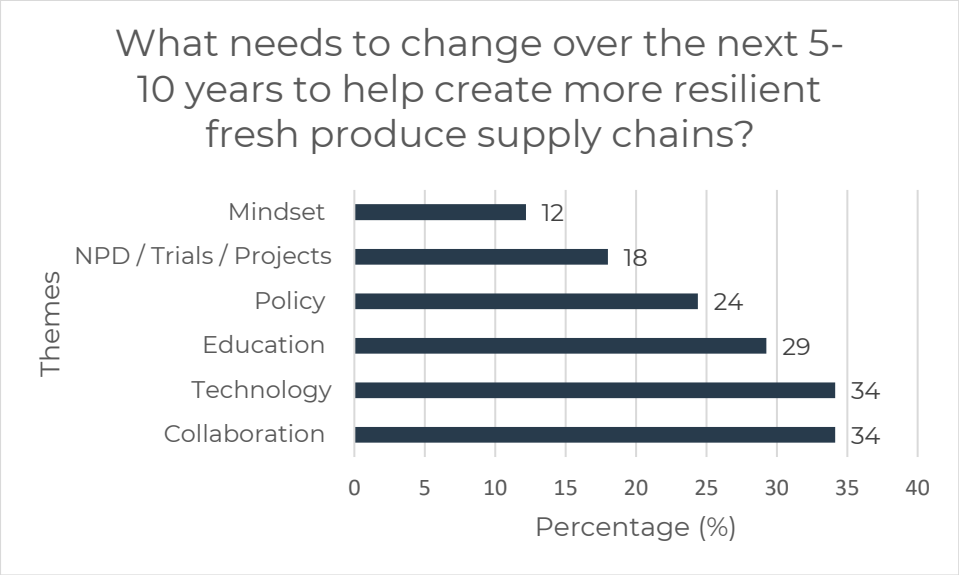

Figure 12 - Common themes of what key stakeholder identified needs to change [Source: Author's own]

6.1.1 Collaboration

What

Thirty four per cent of stakeholders (growers, manufacturers, retail and industry experts) thought collaboration needs to change across the supply chain. Throughout discussions it was clear the supply chain can often work in silos. One grower said *"We need to improve collaboration across the supply chain. The industry needs to work together more cohesively, rather than being fragmented, to present a unified voice and drive meaningful change, especially when engaging with government"*.

How

During my visit to the Netherlands, I observed strong collaboration between seed producers and growers. As food manufacturers, we need to adopt a similar approach by engaging more closely with our suppliers and their growers to

ensure they are exploring future crop varieties that may be critical for our high-risk produce materials.

Improving collaboration within the supply chain requires each sector to distinguish between individual business objectives and shared desired outcomes. This allows businesses to pursue their specific goals while collectively contributing to the sector's desired outcome.

An example for food manufacturers;

> Objectives = *What* you plan to do e.g. Identify all high-risk produce materials and develop a sourcing strategy, including contingency plans for both suppliers and product type.
>
> Desired outcome = *Why* you're doing it e.g. Ensure a more resilient fresh produce supply chain for continuity of supply

This approach enhances collaboration across businesses and sectors to achieve a desired outcome as it supports flexibility (by moving to a new approach without losing sight of the desired outcome) and improves strategic planning.

6.1.2 Technology

What

Thirty four per cent of stakeholders, including growers, policy makers, and industry experts, believe that technology needs to evolve—specifically, to become more prominent in the supply chain due to labour challenges (especially for manual labour-intensive tasks like harvesting). For growers, technological solutions for irrigation and water management are crucial in addressing unpredictable water shortages. Meanwhile food manufacturers and retailers, would benefit from a revised specification system powered by advanced technology, making it easier to adapt to changing requirements. These are just a few insights shared during stakeholder interviews.

How

We need to utilise technology to transform supply chains, which is not always that easy due to the significant investment required. However, I did visit several companies who had adopted these technologies, starting with small scalable pilot projects.

In Chile I visited the first vertical farm in Latin America which has now expanded over five times its original capacity (Figure 13). Although this is part of the solution, we cannot solely rely on vertical farming for our produce due to the cost and current reliance on venture capital investors.

Figure 13 - The Author at AgroUrbana, Vertical Farm, Chile [Source: Author's own]

Another example of technology transforming supply chains is through robotics and automation. During my visit to Dyson Farms, I visited their 10.7 hectares of glasshouses, where strawberries are grown. Interestingly, they have implemented robotic strawberry pickers, to address the labour challenges (Figure 14).

Figure 14 - The Author at Dyson Farms, Lincolnshire, UK [Source: Author's own]

Furthermore, modern technology has significantly improved the ability to collect vast amounts of data, making it easier to understand and assess various risks within the supply chain. This data can be leveraged to enhance risk decision-making, providing more informed and accurate insights, meaning organisations can proactively identify potential risks and take steps to mitigate them, ultimately leading to better strategic planning and more resilient systems (Cabinet Office, 2022).

6.1.3 Education

What

Twenty nine per cent of stakeholders (growers, manufacturers, retail and industry experts) thought education for both the end consumer and food industry needed to change.

How

How we can make and influence change through education for the end consumer is through supermarket messaging. This allows all consumers to make informed choices on what they are buying, like in Senegal they are informing the consumer if produce is imported or local (Figure 15). An example of consumer education in supermarkets is when there is a supply challenge or shortage (e.g. flooding), that the consumers know why. As an example, one British lettuce grower said when there was a sandstorm in Spain, messages went up in the UK supermarkets letting consumers know that the produce looked dirty because of a sandstorm, they found this transparent communication worked well. These small incremental changes will start to educate the consumer so they understand more about food and the challenges which may become more frequent in future.

Figure 15 - Imported and local produce in a supermarket in Senegal [Source: Author's own]

Additionally, I recommend providing educational resources regarding the seasonal sourcing of produce for food manufacturers and retailers, so that this information can be more consistently integrated where appropriate. In my experience, food manufacturers don't always consider where ingredients come from and their seasonal availability when developing new products (more applicable for seasonal ranges).

6.1.4 Policy

What

Twenty nine per cent of growers and 33% of industry experts believed there needs to be a change in policy. Speaking to one grower, this change in policy is specifically around (1) border control improvements post-Brexit to facilitate smoother trade (e.g. plant imports from the Netherlands), (2) a clear strategy to support domestic production thus improving UK food security [1] (3) labour cost management, and (4) energy and carbon policy changes to allow the use of waste heat and carbon from other industries without tax, which could be used to heat greenhouses or used for LED lighting in winter production.

[1] On the 19th May 2025 the UK and EU stuck a post Brexit deal, committing towards a Sanitary and Phytosanitary (SPS) Agreement, reducing paperwork and boarder checks, making it easier to import and export food and drinks (Kidby, 2025).

How

Speaking to policy advisors in Brussels, they said how we can make a change in policy is by turning up and getting our voices heard. Wayne Dredge (2014 Australian NSch) said "*The fate of the world is on the people that show up, so show up*". Therefore, I attended and presented at the 2024 World Food Forum in Rome, which was unique opportunity to see how high-level events run, with representatives from government, ambassadors, NGO's, private sector, students, supply chain & farmers from all around the world (Figure 16).

Figure 16 - The Author, Sally Higgins (2024 Australian NSch), Michael Taylor (2024 Australian NSch), Su McCluskey (Special Representative for Australian Agriculture) presenting at the 2024 World Food Forum [Source: Author's own]

However, my time at the FAO in Rome and at EU consulate in Brussels left me thinking. While there is a shared understanding of the urgent need to address the many challenges facing our supply chains, efforts remain fragmented. Innovative ideas are emerging worldwide, yet they often exist in isolation. Politically it is hard to make a change until there is a crisis (e.g. war or food insecurity), which is why influencing policy changes feels slow, but we can't lose hope. To shape more informed and effective policies, it's essential for stakeholders to engage with industry bodies together (e.g. NFU) and for

policymakers to connect directly with those working in the food and farming industry.

Ultimately, I believe that if we want to drive real change, we need to come up with innovative solutions for our own business and sectors, sharing our learnings for a more connected, collaborative approach.

6.1.5 New Product Development, Trials & Projects

What

Growers, manufacturers and industry experts identified product development, trials and projects as an area for change. Ultimately, food manufacturers and retailers determine what the consumer eats (based on what is available in supermarkets). Therefore, I believe we can play a huge role in the products we develop.

How

In Chile, I visited a sandwich and salads manufacturing company (Figure 17). They typically sell mixed salads which include different varieties of lettuce. This flexibility allows them to navigate shortages or off-season periods for specific lettuce types without significant impact on their production. Therefore, could manufacturers work with their customers to look at different varieties or mixed lettuce types, rather than relying on a few for our sandwiches and salads in the UK. Highlighting this type of contingency planning is not just about having alternative suppliers, but also about ensuring flexibility in the type of produce offered, to maintain a constant produce supply. While this shift will take time, it can be achieved through small, incremental changes and by informing consumers of the reasons behind these changes, to improve resilience in the supply chain.

Figure 17 - Fork, Food Manufacturing Company, Chile [Source: Author's own]

During my visit to one of Poland's largest potato growers (Figure 18), I observed their work on regenerative agriculture trials and collaborations with manufacturers on specifications. Produce is not always perfect, and with increasing shocks in the supply chain, we should consider how to open, rather than narrow specifications (moving to dynamic specifications that adapt to the crop), using factual customer feedback data, which some potato growers in Poland and the UK have done with their customers. Even discussions with UK retailers suggested that opening specifications could be beneficial to ensure supply. In food manufacturing, widening specifications could help guarantee supply, with most consumers unlikely to notice minor changes in produce variety. As long as the taste remains acceptable, and food continues to meet safety and quality standards.

Figure 13The Author, Top Farms, Poland [Source: Author's Own]

6.1.6 Mindset

What

First, we need to shift from short-term to long-term thinking with sustainability and resilience in mind. Interestingly, all stakeholders (apart from retailers) thought there needed to be a change in mindset. In interviews, one UK manufacturer said, *"we need to change our mindset to be more proactive, not reactive as we currently are"*.

How

While I was in Kenya, I visited Stuart Barden, a broad acre cropping farmer, who moved from Australia to Kenya 13 years ago (Figure 9). Stuart said *"Be bold, have the courage to take risks and make the first move."* It often takes one person to be bold and start a trend. I admire Stuart for his change in mindset, proving that crops can be successfully grown in areas with limited rainfall. His story was inspiring!

Figure 19 - The author and Stuart Barden (2009 NSch) at AusQuest, Kenya [Source: Author's own]

6.2 Who is responsible?

There is automatically a tendency to point fingers at different stakeholders in the supply chain to act and make change, but we can't leave this to one sector. 'Everyone' within the supply chain (including consumers) has a part to play, which was a common theme from my research.

CHAPTER 7: SOLUTIONS – A ROADMAP FOR SUCCESS

Based on my travels, we can't escape the fact the challenges affecting the fresh produce supply chain are increasing. The focus on short-term efficiency over long-term resilience, increasing complexity, a lack of shared responsibility, and slow adaptation of technology and policies within the supply chain means we are backing ourselves into a corner. This situation may be driven by a limited ability to imagine a different future from the present, along with a lack of understanding of the solutions needed to build a more resilient fresh produce supply chain

Ultimately, businesses will need to adapt, be flexible and more resilient. I have taken the learnings from my discussions with stakeholders around the world and built them into a roadmap for success for every stakeholder in the supply chain to ensure a more resilient fresh produce supply chain in the UK.

First, we need to separate objectives from desired outcomes. The desired outcome is to ensure a more resilient fresh produce supply chain, and the objectives will be specific to every business within the supply chain to achieve this, as outlined in 6.1.1.

7.1 A Four step approach

Fundamental to this approach is a change in mindset, with a willingness to adopt new ways of working.

Step 1 - Resilience risk assessment and contingency planning

Introduce a resilience risk assessment which is built on data from supply challenges and customer feedback. This will allow businesses to prioritise risks according to their unique needs and challenges. The specific details of the risk assessment will vary for each stakeholder within the supply chain, as each faces different risks and vulnerabilities.

An important aspect of the risk assessment is contingency planning, which should not only focus on having alternative suppliers but also on ensuring flexibility in product types, as outlined in 6.1.5. It's crucial that all contingency raw materials/items are signed off in advance. This proactive approach ensures that businesses avoid last-minute firefighting when supply challenges arise.

The risk assessment should begin by clearly identifying all risk dimensions (e.g. economic, environmental, social etc.), which is specific for each stakeholder (and business) within the supply chain. For growers, these risks will align with the challenges outlined in Chapter 4. Further up the supply chain, risks are more likely to be shortages in raw materials or finished products (due to challenges faced by growers). For policymakers, the ultimate risk could be a complete disruption in food supply. All businesses should have mitigation, and adaptation plans for all the identified risks recorded on the risk assessment and revisited

whenever there is a supply chain challenge (even if it did not impact your business).

Step 2 - Key actions by stakeholder

The following actions are informed by observations from my Nuffield travels of how businesses around the world are building resilience.

Everyone (including consumers)

- Willingness to adapt and be flexible
- Businesses should strive to be 'business reimagined'
- Mindset change
- Collaboration
- Education (up and down the supply chain)

Grower

- Spreading risk through different geographical planting locations (where possible)
- Adopting regenerative farming practices
- Technology adoption
- Climate smart adaption on farm (e.g. using drought resistant seed varieties, water management, crop diversification, soil conservation etc.)
- Longer term contracts

Manufacturer

- Supplier relationships
- New product development trials and projects
- Dynamic specifications using factual customer feedback data
- Seasonality education
- Technology adoption
- Longer term contracts

Retail

- Supplier relationships
- Product development trials and projects
- Opening specifications using factual customer feedback data
- Technology adoption
- Longer term contracts

Policy

- Strong UK food security policy

Step 3 - Transformation

Building resilience requires an upfront investment of time and resources, but the long-term economic impact of inaction will outweigh these initial costs. These actions (in steps 1 – 3) will slowly move to transformation. As consumers continue to be influenced by the media and retailer messaging, their demand will support change across the supply chain (e.g. product and packaging development changes).

Step 4 – Future planning

It is vital resilience plans are continually monitored and adapted, depending on emerging risks and insights. In some cases, businesses may need to loop back to Steps 1, 2, 3 or 4 within my five-step approach methodology (Figure 20). This adaptability is critical to maintain relevancy and achieve a more resilient fresh produce supply chain in the UK.

Figure 20 - A Four Step Approach Infographic [Source: Author's own].

CHAPTER 8: RECOMMENDATIONS

Chapter 4: Resilience

- Resilience is the ability to adapt and be flexible.
- Operational flexibility is the missing link to ensure both a lean and resilient business.
- A truly sustainable business tends to be the most resilient (and vice versa).

Recommendation 1: The key to successfully combining resilience with lean practices lies in operational flexibility. To achieve this, businesses must strive to be 'businesses reimagined', rethinking their operations with adaptability and flexibility at the core. This means investing in readiness and ensuring both efficiency and long-term resilience at every stage of the supply chain.

Chapter 5: Challenges facing fresh produce supply chains

- Stakeholders around the world have shared various challenges affecting their businesses. Whether it's a lack of rainfall in Senegal, logistical issues caused by geopolitical tensions in Kenya, or economic pressures due to rising input costs in the UK.
- It's clear that many more challenges will continue to arise, some of which will be impossible to predict.

Recommendation 2: All stakeholders within the supply chain need to continuously adapt in a timely manner to the unknown challenges in an ever-changing world.

Chapter 6: Key Stakeholder Opinions

- Identifying what needs to change and how we can make and influence change within the supply chain, can allow focused and targeted change:
    - Mindset - Shift from short-term to long-term thinking with sustainability and resilience in mind.
    - Policy - How we can make a change in policy is by turning up and getting our voices heard.
    - Collaboration – Separate objective from desired outcomes.
    - Education – Seasonality education for food manufacturers and retailers' New Product Development (NPD) briefs.
    - Technology - Data can be leveraged to enhance risk decision-making.
    - Product development, trials and projects - Contingency planning is not just about having alternative suppliers, but also about ensuring

flexibility in the type of produce offered, to maintain a constant produce supply.

- Responsibility - Everyone is responsible for protecting the fresh produce industry.

Recommendation 3: All stakeholders must take shared responsibility to influence and lead change across the supply chain, ensuring the long-term resilience of the UK's fresh produce sector.

Chapter 7: Solutions – A roadmap for success

Building a resilient fresh produce supply chain requires a fundamental shift in how we think and operate (mindset change). Therefore, something needs to change, and businesses will need to adapt and be flexible, to be more resilient. We don't need to make big changes; small incremental changes will go a long way to achieve success.

Recommendation 4: All stakeholders in the fresh produce supply chain should adopt the four-step approach, which was developed following my Nuffield Study Tour (this approach can also be adopted by other food supply chains). The steps are:

(1) resilience risk assessment and contingency planning

(2) key actions by stakeholders

(3) transformation

(4) future planning

Adopting this approach across the supply chain through small, incremental changes is my final recommendation to ensure a more resilient fresh produce supply chain in the UK.

CHAPTER 9: AFTER MY STUDY TOUR

Completing a Nuffield Scholarship has been an incredible experience. Over the past 18 months, I've been pushed out of my comfort zone, gaining confidence, developing both personally and professionally. Stepping back from my day job to undertake my travels gave me the opportunity to study my research topic with a fresh perspective and truly challenge the status quo - something I set out to do from the very beginning. I often asked myself: if we've always done something a certain way, is this truly the best way to continue?

In my day-to-day role, I often face supply chain challenges with raw materials. After completing my Nuffield travels, I now have a deeper understanding of the root causes - gained from seeing first-hand what's happening at every stage of the supply chain. It can feel demoralising facing repeats of the same supply chain challenges year after year, but now I feel informed and equipped to address these challenges.

Since returning from my travels, I have started to put in place my recommendations from my Nuffield study. As I mentioned in my roadmap for success, fundamental to this approach is changing mindset (which doesn't happen overnight). I have started this process by speaking at conferences, also presenting to the Samworth Brothers Group Executive Board and procurement teams to share the insights I've gained on resilient supply chains. I look forward to continuing this activity now that my travels have concluded.

I genuinely believe that the roadmap for a more resilient fresh produce supply chain is practical, achievable, and something I'm eager to continue to implement in the food supply chain.

CHAPTER 10: ACKNOWLEDGEMENT AND THANKS

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CHAPTER 11: GLOSSARY

- European Union (EU)
- European Union Emissions Trading System (EU ETS)
- Food and Agricultural Organisation (FAO)
- Light-Emitting Diode (LED)
- National Farmers Union (NFU)
- New Product Development (NPD)
- Non-Governmental Organisation (NGO)
- United Kingdom (UK)
- World Food Forum (WFF)

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APPENDICES

Appendix 1 – Countries Visited on Nuffield Travel

Where	Comments
UK January –September 2024	Teams' calls/day visits with growers, food manufacturers, retailers and industry experts, to learn and understand what is happening in the UK. Visits included; AH Worth, Haygrove, Barfoot's, Tesco, G's Fresh, APS Group, Agrial, PDM, Fairshare, Samworth Brothers, Dyson Farming, Westfalia.
Germany February 2024	Fruit Logistica 2024, Berlin - The world's largest trade fair for the fresh produce industry
Brazil March 2024	Contemporary Scholars Conference – Campo Grande and Bonito.
Chile April 2024	Chile is a large fresh produce producer and exporter. Visits included; Los Olmos Seed Nursery, Mayer, Ferrero, Agrosana, Agrourbana & Fork Manufacturers.
Netherlands May 2024	Netherlands is one of the largest exporters of agricultural products in the world, a large proportion of which is fresh produce. Visits included; Syngenta, Wageningen University and Quality Produce International.
Poland August 2024	A trip focussed on potatoes, an integral raw material for our ready meal's businesses. Visits included; Farm Tech & Top Farms.
Italy October 2024	Attended and presented at the World Food Forum. Attended the Committee on Food Security.
Kenya October 2024	Kenya is a large fresh produce producer and exporter. Visits included; Kakuzi PLC., Stuart Barden, Tambuzi, Bioline & Sunripe manufacturers.
Senegal November 2024	Growers are supplying the UK and EU, to ensure 52 weeks a year supply of produce. Visits included; West Africa Farms, Quality Fruits Senegal (QFS) and Societe De Cultures Legumieres (SCL).
Spain November 2024	The Murcia Region, one of Spain's main fresh produce growing regions, with the UK being one of their primary export markets. Visits included; AH Worth, G's fresh & Intercrop.
Belgium November 2024	EU Consulate to discuss food & agricultural policy.
Japan March 2025	Japan is known for its technological advancements and innovations. Japan also grows a lot of fresh produce. Visits included; Green Leaf food manufacturing, Asai Nursery, organic vegetable and dairy farms, Wagyu beef breeders and Toyota manufacturing.

Appendix 2 - Interview Questions

Challenges

1. What are the biggest challenges/risks (financial and non-financial) facing your business and fresh produce supply chains over the next five years?

2. How are you preparing for/mitigating these challenges?

Key Stakeholder Opinions

3. How would you define fresh produce resilience?

4. What needs to change over the next 5-10 years to help create a more resilient fresh produce supply chains?

5. How can we make and influence change in the fresh produce industry?

6. What do you believe the future of the fresh produce industry looks like over the next 5-10 years (positive/negative/mixed opinion)?

7. In your opinion, who is responsible for protecting the fresh produce industry (grower/manufacturer/retailer/policy/consumer/everyone)?

Solutions

8. What do you believe are the opportunities and solutions for ensuring resilient fresh produce supply chains?

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