



**A Nuffield Farming Scholarships Trust**

**Report**

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**MacRobert Trust**



**Improving connectivity in the  
seed potato supply chain**

**Claire Hodge**

**October 2020**

**NUFFIELD UK**

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# A

## Nuffield (UK) Farming Scholarships Trust Report



*'Leading positive change in agriculture.  
Inspiring passion and potential in people.'*

Date of report: October 2020

|                          |  |
|--------------------------|--|
| Title                    | Improving connectivity in the seed potato supply chain   |
| Scholar                  | Claire Hodge   |
| Sponsor                  | MacRobert Trust  |
| Objectives of Study Tour | Explore how connectivity in the potato industry impacts farming systems. Identify strategic partnerships and factors which will enhance connectivity through the potato supply chain.  |
| Countries Visited        | Kenya, India, Brazil, Chile, USA, UK and EU  |
| Messages                 | <ul style="list-style-type: none"><li>• Focus on types of information that can be shared without losing commercial advantages.</li><li>• Creating shared goals and incentives through the whole supply chain</li><li>• Shared investment in technology and innovation</li><li>• Increased transparency in production data to create value for all parties</li><li>• The UK potato industry can lead the future of potato production through global collaboration</li></ul> |

## EXECUTIVE SUMMARY

The potato has huge potential as a world food. Scottish seed potato producers have been leading the world in their approach to managing risk and producing high quality seed. However, the task of growing high-grade potato seed has become harder in recent years with heightened customer expectations and changing weather patterns.

My intention before my Nuffield travels was to better understand supply chain frameworks that help connect the industry by establishing how digital tools and business structures support connectivity in a supply chain. I thought this would focus on the sharing of technical and market information. I chose to travel to emerging markets such as Kenya, India and South America, where the population is high, and potatoes offer an opportunity to increase production in these emerging markets, where the number of growers is high and many of the supply chain frameworks are in their infancy. I compared these to well-established markets in the USA, the Netherlands and the UK, where, in contrast, numbers of growers are falling and supply chains are multi-level and complex.

Throughout my travels, I observed that connectivity was not just about the framework of the supply chain but, most importantly, about the mindset of the people within it. This report looks at examples of connectivity around the world in the potato industry from a farmer in Kenya, teaching other farmers to whom he supplied seed potatoes and training them in planting and managing potato crops, to growers' groups in Chile sharing expertise and overcoming challenges in accessing markets, and to large businesses in India which are thriving by accessing global funding.

I found that the global potato industry is full of opportunities and is constantly expanding in its ability to connect. On reflection, the UK has a complex supply chain that has become technically detailed in order to produce a consistent product. These chains are often linear and not circular, and there is a need to connect the seed producer at either end of the chain, to researchers and the consumer at the other, so that the whole industry can respond to challenges and change faster. Tools and technologies, for instance, are being used to enhance communication throughout the supply chain and examples of growers leading this change can be seen around the world.

The global potato industry has technology readily available to it which can address consumer demands; however, this will mean redesigning the current structure that Scotland has become an expert in. Science and technology are advancing and bringing new opportunities to current potato breeding programmes, which will change the way the industry connects from seed producer to consumer. Now is a good time for the Scottish potato industry to establish how potatoes will be grown in the future and be part of the growth in potatoes as a global food. This will require strong connectivity throughout the industry with a focus on customers, the environment, policy, technology and the economics of production.

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## **DISCLAIMER**

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## 1. Personal Introduction

I grew up in the Scottish Borders, surrounded by cows on my parents' thriving dairy farm, which has had a huge influence on my life. Fundamentally, our family enterprise had a vision: to produce quality products for market, whether this was through animal breeding, herd performance or financial reinvestment. I was in and around a successful business that paved the way for my ambitions of working within agriculture. Little did I know that this would lead me to a career in potatoes. However, the principles of delivering high quality produce are similar across the industry and match my ambitious nature.



*Figure 1: Claire Hodge*

Passionate and determined for UK agriculture's positive future, since graduating from Newcastle University 2005 with a Degree in Agriculture (Hons animal production), I have been fortunate enough to achieve a successful and enjoyable career within the potato industry. My first experience of this industry came shortly after leaving university. I'd spent some time in New Zealand milking cows and I was unsure of what might come next. I was then given the opportunity to work for local potato growers and packers, Greenvale AP. Coming in as a fieldsperson gave me a great opportunity to learn the industry, although this did not come without hard work and long hours – a good introduction to what was ahead of me.

I found real enjoyment in working with various teams, monitoring the crop through all stages of the production process. For me, a key part of this process was seeing the end product on supermarket shelves. Knowing where that product came from and what work had been done to get it there gave me a sense of pride. Subsequently, getting the quality right became a real passion and interest such as how to work with farmers and the business's own growing teams to ensure we all knew what we were working to achieve.

While undertaking my Nuffield study travels I worked for the Agriculture and Horticulture Development Board (AHDB), the national levy organisation supporting farmers. Here I collaborate with farmer, research and governmental networks. My role is to work with farmers to see how research results might be applied to current practice and to assess the cost and benefit of adopting such changes. This comes with many questions, and if my time in agriculture has taught me anything it's that you never stop learning.

With a focus on seed production, which is a critical stage in the production system and one that has many quirky anomalies, I spend much of my time asking growers and the wider industry about what they do and how they achieve their goals. I used this experience on my study tour.





## 2. Background to my Study Subject

Scotland's reputation for seed potatoes is second to none. Our high health standards for potato seed crop illustrate the collaboration, trust and expertise the Scottish potato industry has – allowing us to boast – some of the best seed potatoes in the world.

Despite this reputation, there is a fast-increasing need to stay competitive on the global market. As countries with developing potato enterprises in Europe, Africa, and Asia and South America gain momentum, it is imperative that the UK potato industry keeps its advantage by challenging current practice by setting standards to stay competitive. That will require the embracing of new technology that pushes the boundaries of innovation.

A constraint is that the potato is a multi-generation crop, taking on average in the UK 6 years to multiply seeds to a level to enable production on a commercial food supply scale. Seed potatoes are the daughter root crop produced yearly and therefore maintain genetically identical seed stocks. It is therefore important to protect and nurture these seed systems to ensure reliable to type production.

With a focus on the seed potato sector, my Nuffield Scholarship was to investigate connectivity in the supply chain. Specifically, to examine research-led innovations on farms, including the uptake of precision farming and the use of on-farm monitoring, creating networks of shared information concerning on-farm data and building on our learning from the technology at our disposal. As part of researching global “best practice” I took a close look at the communication between seed producer and purchaser in order to discover the sharing of information and how it affects the whole supply chain. My study also considered how emerging and established markets operate and there by discover new opportunities. As background to this, I also outlined how plant health standards set by governments support agricultural production and global trade.

My aim was to focus on the sharing of technical information, which has potential to increase productivity and reduce pest and disease risk, and to establish an understanding of where the UK potato industry can concentrate its attention to ensure there is continued export of expertise and professionalism with exciting trading potential. Through these routes I hoped to arrive at a whole industry vision to change the way potatoes are grown, to capture the crop's full potential as a sustainable source of nutrition.



### 3. My Nuffield Farming Study Tour

Through my career in the potato sector I have been fortunate to have visited and learnt from countries with standards and systems that are similar to well-established ones in the UK. For my Nuffield travel I wanted to ask new questions and consider different ways of potato production.

To do this, it was important to meet with seed growers and their customers and all the people involved in delivering the product on the shelf. It was therefore important to capture people's views from a wide range of positions: farmers, researcher, lobbyists, politicians, marketers and consumers.

| COUNTRY | REGION                              | DATE                 | PURPOSE   |
|---------|-------------------------------------|----------------------|---|
| KENYA   | Nairobi, Central Meru, Nyandarua    | Oct 2019             | Seed production systems linked closely to European breeding programmes.             |
| INDIA   | Ludhiana, Jalandhar, Ganghinagar    | Oct 2019<br>Jan 2020 | World's second largest producer of potatoes. Global Potato Conclave.                |
| BRAZIL  | Canoinhas, Ireneopolis,             | Nov 2019             | Growing domestic market, seeking to reduce reliance on North American seed systems. |
| CHILE   | Puerto Varas, Frutillar, Llanquihue | Nov 2019             | Similar climates in Scotland and low domestic population.                           |
| USA     | Las Vegas                           | Jan 2020             | Potato Expo – National potato industry conference.                                  |
| EU/UK   | Belgium                             | Nov 2018 – Feb 2020  | Potato Europe & Industry interviews and academic/theory review.                     |



**Figure 2. Countries visited**



## 4. Potatoes and the Environment

Potato production is more environmentally sustainable than rice or pasta, with low base production CO<sub>2</sub> output and relatively efficient water use. Westernised potato systems are highly mechanised and hard to change, driven by the need for high returns. In emerging markets, where production systems are low input and reliant on manual labour, there is a greater opportunity to integrate systems more closely with environmental considerations.

### 4.1 Potatoes – A Sustainable Crop in India

Water is a valuable resource around the world but in Punjab, India, this issue cannot be ignored. This is a region with highly productive land, which has been relied upon to feed the country with vast amounts of rice and cereals. Government support has been in place for many years to build infrastructure to help farmers access water. This support, in part, has been in the form of subsidised electricity to irrigate rice paddy fields.

During my time in Punjab I met with researchers, students and farmers who were conscious that current systems are unsustainable. They see that potatoes are a crop that could provide new opportunities as potatoes rely on much lower levels of water and offer high nutritional output. Potatoes are planted after rice where the seasons allow multiple crops in one year. This utilises established irrigation infrastructure and produces food with the highest calories per litre of water compared with maize, rice and wheat. As with all crops, yield to water efficiency is dependent on water application timing. Additionally, this improved efficiency of land use by increasing potato production will need to be supported by seed supply to match demand. With potatoes now beginning to be seen as a valuable crop which can contribute to meeting world food demand, the potato industry has a real opportunity to promote, foster and support that demand.



**Figure 2: Planting seed potatoes after rice, Punjab, India**



## 4.2 Regenerative Systems in Kenya

One of the key things I noticed when I visited Kenya is the difference in their farmers' approach to land development. I visited farms growing five acres to over 700, and when visiting small scale farmers who started with very little, I saw that much of their learning had come from their own experience of successes and failures at their own risk. It is evident that every piece of land counts when you only have five acres and only modest profits are achievable. Moreover, environmental gain does not need to be at the cost of commercial progress, in fact it can accelerate it.



**Figure 3: Muthome, Kenya: 'Why farm more land, when there is still more I can get from the land I have?' (2019)**

Muthome who farmed five acres in Kenya changed the way I saw how land can be utilised. He created a dynamic flow between crops by concentrating on what he had. He understood what his land needed to produce crops and potatoes were the core of his income. His system was based on four rotational crops, four cows and a lagoon. He was capturing the potential of every space, building-in composting the waste from cattle and developing new ways to reduce waste in the cycle. He was trialling new varieties and in doing so had increased his output fourfold. There was so much to learn from someone who had a different perspective to many of the growers I had met before. This system protected the environment with more resilient soils, increased crop diversity and sustained efficient water use.

**Summary:** When potatoes are being adopted as new crops, the issue of how best to integrate production with environmental considerations is brought to the fore. Countries and producers new to growing potatoes can combine growing a very productive crop with reducing costs by building in environmental considerations as well.

The next chapter addresses the impacts of potato growing on local economies and society.



## 5. Potatoes and Social Aspects

I chose the countries I travelled to on their market potential and the uptake of new technology but became aware also of the importance of the pivotal role that agriculture plays in developing countries' communities. The support it provides in building rural communities and helping those in areas of poverty is evident just from spending small amounts of time there: Agriculture is the foundation of communities and improvements in it can help alleviate poverty.

### 5.1 Potatoes as a Cash Crop

From a UK perspective “cash crops” illustrate a great opportunity to build capital, although at high risk.

The story of humble beginnings in the potato industry can be seen across the globe – great risk often means greater reward, and for many developing countries this is a risk worth taking.

The Kenyan Potato Council work with over 80,000 growers. When I met with them, they explained that a high percentage of people in rural communities responsible for the potato crop are women who have very small plots of land. The planting of potatoes became traditional alongside the colonisation of Africa in the 1800s. This coincided with cultural tribal changes and more production in village units rather than the hunter-gatherer way of life which previously prevailed. The high numbers of women responsible for the production of potatoes is thought to be because potatoes not only provide households with healthy nutritious meals for the family but also, when good yields can be achieved, provides additional income. This extra income for the household is often spent on the children's education.

Linking these small growers to a local market becomes extremely important. I met with Florence Kinoti, chair lady of Kiririma Potato Cooperative in Timau. Florence, a retired headmistress, was helping people in her community grow potatoes. Her successes so far included setting up shared potato storage facilities for the community and embarking on building a water lagoon on her own land.



**Figure 4: Florence Kinoti, Kenya**





## 5.2 Co-operation and Collaboration in the Farming Community

*'In helping local farmers to learn about growing potatoes and the value of seed potatoes here on my farm, I am also looking after my customer' (James Nairodi, 2019)*

I met a young farmer in Kenya, James Nairodi, who was a first-generation high-grade seed grower. He was an advocate for young people being supported to enter the world of agriculture. I was amazed with what I saw when visiting his site. He had rented around 60 acres of land and borrowed money to start his business. Realising that small scale farmers lacked access to quality seed and higher yielding varieties, he worked closely with the whole potato industry in Kenya and planted apical seed stocks, an approach which is encouraged by the International Potato Centre, CIP. Apical seed is a technique not often used in the UK market; however, when access to quality clean seed is limited this propagation technique is an affordable approach. Cuttings are produced from tissue culture plantlets which are clean and free from disease. In six weeks, one mother plant can be multiplied to produce eight plants.

While I visited him in the field he had eight local farmers on the land planting seed. He used his business as a training ground for local farmers who purchased his seed potatoes. He helped them to learn cultivation, planting and crop management techniques.

He spoke enthusiastically about the potato industry and had great determination to succeed.

However he had two major issues of concern:

- Firstly, access to funding is important for a young new entrant to agriculture to be able to progress;

- Secondly, he spoke of the challenge that he faced selling certified seed to farmers who had never seen the potential of using certified seed product and so it was hard for him to expand his market.

To overcome these issues, he brought local farmers to his fields and was able to show them the increase in yield that they could get from using his seed, benefiting both parties. Something I often saw on my journey, was the incredible sense of community and the importance of supporting others to ensure the foundations of a commercial enterprise. While I visited his farm a group of scientists from a nearby university had travelled to his field to learn about his business and seed potato production in the region.



**Figure 5: Scientists visit field to learn local systems**



**Figure 6: James Nairodi, Kenya**



### 5.3 Healthy Diets

Globally the potato has a bad reputation linked to obesity via fast food. I travelled to America where organisations are trying to address this image. Potatoes USA are the marketing organisation for the 2,500 commercial potato growers operating in the United States.

‘Nutrition Facts in Potatoes, Fuel Performance’ is a national campaign designed by Potatoes USA to promote the health benefits of potatoes to stay fit and healthy. Potatoes can offer high level of fibre, Vitamin C, Iron and B6 in a balanced diet. The way people in Western society consume potatoes have changed significantly since a shift in demand from fresh to processed food. Due to changing consumer behaviour, fast, often processed, food has become more popular. This shift has created a perception that potatoes are unhealthy. In developing Asian markets where potatoes are not so traditional in their diet it is hard to change this perception created by Western world media portrayals of unhealthy diets.

However, the health benefits of unprocessed potatoes are that they are a great nutritional source for people who need it the most. Potatoes USA’s 2019 marketing advert, see Figure 8 on the next page, aimed to make this point:

*‘If you’re looking to power up your performance, look no further than the potato. Did you know that potatoes provide the carbohydrate, potassium and energy you need to perform at your best? Potatoes are more energy-packed than any other popular vegetable and have even more potassium than a banana. Plus, there’s a potato performance recipe option to fuel your body and brain throughout the day – whether you lead an active lifestyle or are competing with elite athletes.’*

Many potato growers and industry leaders are eager to increase potato consumption per head to increase their market share. They see that by influencing the government to promote the nutritional values of the potato this can also encourage policy to support the production and consumption of the potato.

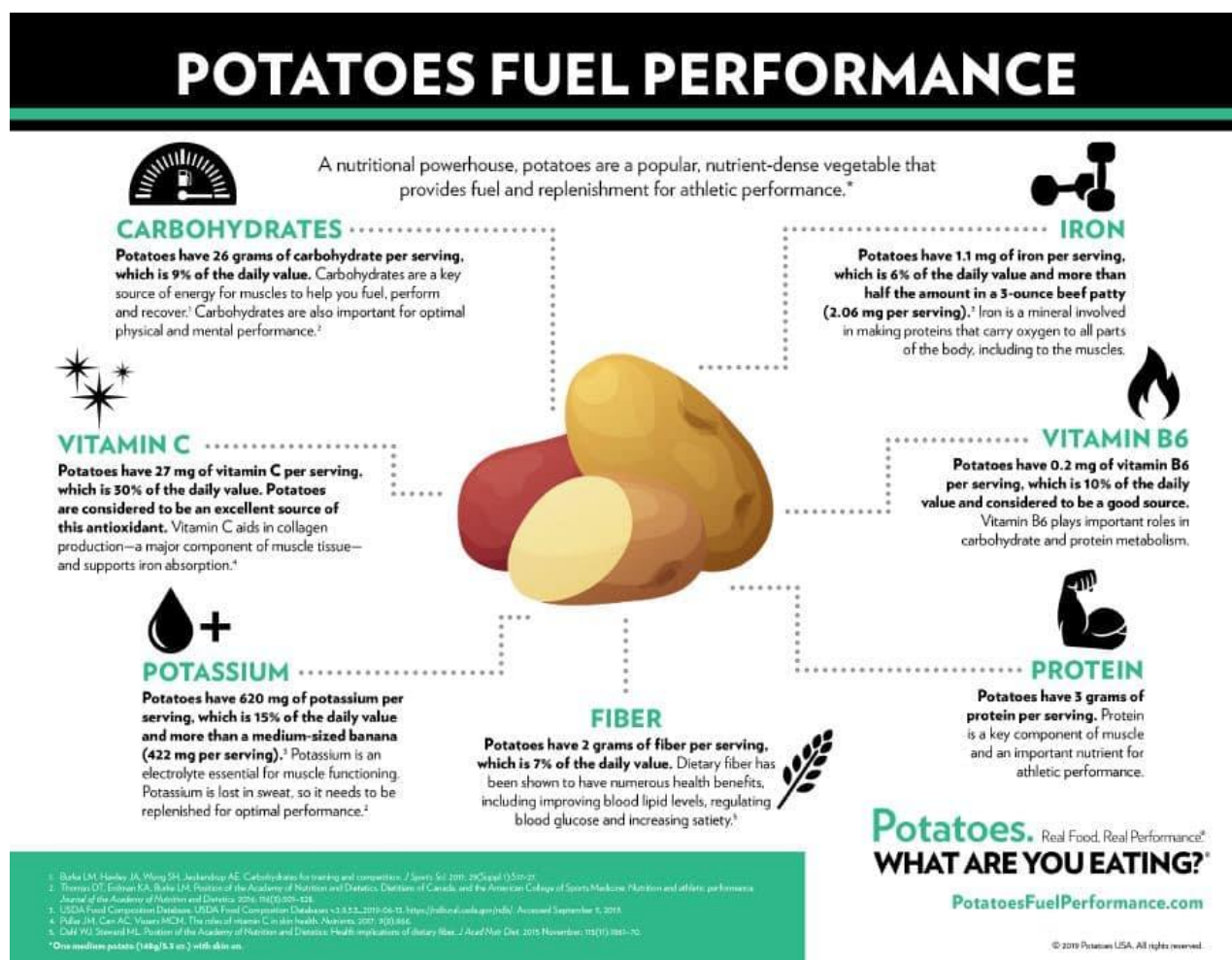


Figure 7: Potatoes USA Marketing Campaign

**Summary:** the marketing and industry support to build connectivity in the global supply chain of potatoes leads to many social benefits: in particular, increased income opportunities taking people out of bare survival, contributing towards healthier populations, and spreading the word about the benefits of beginning with good seed potatoes to protect the environment.

The next chapter addresses aspects of the supply chain.





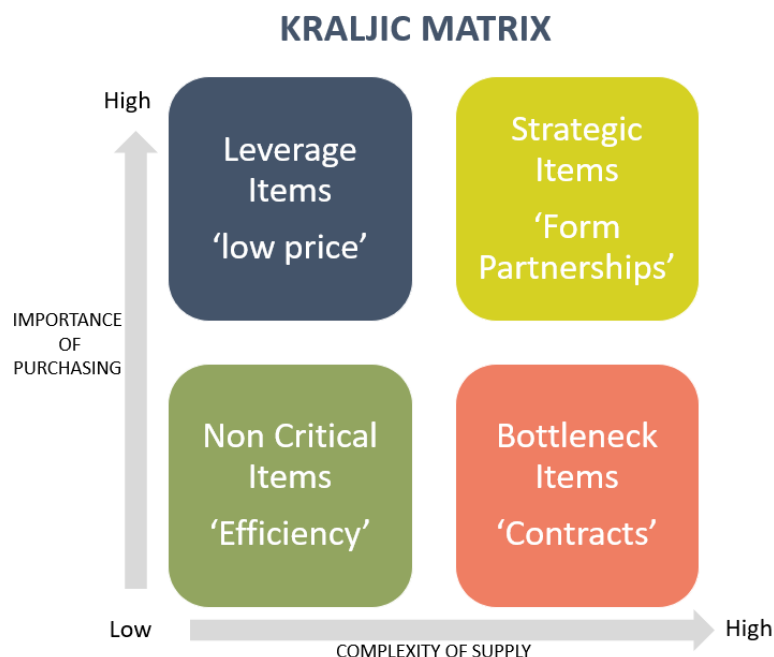
## 6. Supply Chain Strategic Partnerships

Improving connectivity offers huge potential in many of the emerging markets I visited. Connectivity in agricultural supply chains is multifaceted. In modern agriculture many digital platforms exist to easily connect within in and across food/consumer and research chains that previously would not have been available or would have required structural investment.

### 6.1 Supply Chain Theory

Before I started out on my travels, I wanted to better understand what I had experienced through my time working in the fresh produce industry. This led me to exploring the theory behind food supply chains and speaking to Professor Samir Dani, Professor of Operations Management and Deputy Director at Keele Business School. He explains supplier segmentation using the Kraljic matrix, breaking down supply chain relationships into four purchasing items: leverage, noncritical, bottleneck and strategic. Kraljic advises, 'Strategic items are of high importance to the company. The focus should be on ensuring that there is no disruption to supply. The company should aim to develop long-term supply relationships, analysing and managing risks regularly and planning for contingencies. (1983)'

Seed potatoes should be considered a strategic item by potato growers as they are highly important to the whole supply chain and very complex to produce, and seed potato growers need to be aware of their products place in the market to maximise the value of producing a specialist product.



**Figure 8: Kraljic matrix, Peter Kraljic, Harvard Business Review, 1983**

The Kraljic theoretical model: a strategic supplier will usually be producing items that only a small supply base can produce. Suppliers will be in very close working relationship with the buyer. These suppliers will be involved in new product development, will have shared assets and intellectual



property, and the supply will be important for the buyer. Levels of risk will be high, and the supplier will work with the buyer in a proactive approach to mitigate risk. Relationships will be based on transparency, joint communication and sharing of operational information; in other words, based on interdependence. The supplier also has sufficient power in the relationship to manage price and quality standards.

Bearing in mind these considerations, finding examples of sharing information and increasing communication in the whole potato supply chain was an important aim for my travels. I unearthed examples where information was shared by multiple stakeholders in the supply chain. Stakeholders who were able to share information to improve efficiencies. I found this in several places and these are described throughout this chapter and in Chapter 9 where technology can be used to strengthen this communication.

## 6.2 Connectivity in Practice

While in Chile I met with Ivette Acuña, the lead potato researcher at INIA, Chile's national research centre for agriculture. She explained that there were 30,000 potato growers based in the southern seed growing area (70% of all potato growers in the country). Yield was variable depending on the uptake of technology and seed quality was an issue for the potato industry in Chile. Farmers were not using certified seed and opting for home saved or non-certified seed of lower specifications. Seed production is protected in Chile, with no imported seed allowed in. Growers are dependent on six commercial varieties for the fresh market.

The role of the research institute was to support all potato farmers in Chile and with potato virus PVY<sup>NTN</sup> on the rise in seed stocks there was a need to connect to all growers to reduce risk for the industry. Ivette had been involved in setting up a national blight monitoring service which was helping farmers manage field risk and advise growers what action to take. This programme followed in the footsteps of an initiative set up in the UK in the early 2000s, 'Fight Against Blight'. However they took it further by associating each area to a risk code, which allowed farmers to know when to act. This was a great example of connecting people with data by using digital platforms. For this reason, internet poverty is rising up the political agenda in all countries because of the power of educating people it can bring with it.

Building these strategic partnerships proved extremely powerful for the farmers that I met, where they had trust in sharing information and could then look forward to building their businesses. An important element to this, which was out of their control but proved to be critical to success, was understanding the markets that they were supplying.



*Figure 9: Ivette Acuna, INIA, Chile*



## 7. Markets

To consider the global food market, is to also reflect on its trends, geographical obstacles and niches.

### 7.1 The Global Food Market

Global potato markets can be extremely volatile, making potato growing a gamble. In his McCain 2019 'review of the Scottish potato farmers', Rob Scott interviewed a number of potato growers who had established very successful businesses due to the demand for Scottish seed potatoes. Many growers recall the year of 1975 where top seed prices reached £5700 a ton in Scotland, a premium vintage for farmers. There have also been years of lower prices due to reduced demand following a year of main crop failure and volatile seed export markets. The need for growers to forecast external risk to their businesses is becoming even more critical, and this was reflected in farmers' experiences I met around the world.

Understanding the global potato market and economic signals is not just about looking at the potato crop in isolation. The global food market influences what is happening in agriculture, including what the future holds for the potato industry.

Prof Hughes (*Keynote presentation to the Scottish potato industry, SPOT Scotland conference 2019*) explains that the world population is projected to reach 10 billion by 2050, and he investigates what this could mean for farmers and farming as an industry and what food could be produced as numbers increase. It is the detail in this growth that matters: Europe will remain relatively static while countries in Africa and Asia will see exponential growth with consequential changes in social and economic diversity which will influence consumers' diets. To become part of a global food network, the potato industry must focus on consumer demands and respond as the market changes, making sustainability and nutrition even more key issues. Moreover, building strong global market connections can help farmers spread risk and increase their market share.

### 7.2 Global Trends

Population growth, added to the effects of climate change, is putting increased pressure on the agricultural environment. The greatest impact of extreme weather changes and rising sea levels in Africa and Asia will put people's homes and agricultural land at risk. In areas where food is needed most agricultural land will be lost at the greatest rate. Agricultural production will be under great pressure to adapt, and this will put strain on global food systems, as never seen before in modern times. The potato offers opportunities to have a positive impact on these trends: the Rabobank World Potato Map (Figure 11), shows how the potato crop is becoming increasingly important as a global food and shows trade flows of fresh potatoes in blue and frozen products in orange. The map demonstrates:

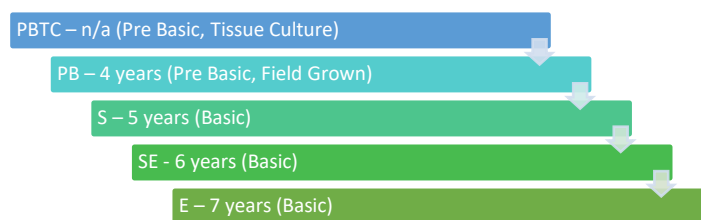
- Frozen potato trade imports occurring outside of Europe and North America, with countries in Asia, the Middle East and Latin America leading consumption growth,
- 80% of frozen exports are from four countries: Netherlands, Belgium, Canada and the US,
- The Netherlands have over 50% of global seed exports,
- The volume of exports of fresh potatoes grew by around 2.5% annually, still dominated by Europe but increasing demands are occurring in Africa and Asia.



### 7.3 Consumer Habits

Equally, around the world the market demands, which farmers serve, are changing constantly. The food sector is fast paced. It is essential to keep up with trends by understanding environmental global pressures, societal dynamics and consumer priorities that impact all businesses.

Seed potatoes produced and marketed in Scotland must be classified under the Seed Potato Classification Scheme (SPCS). SASA (Science and Advice for Scottish Agriculture) is the Certifying Authority for seed potatoes in Scotland and administers the scheme. It is part of the Scottish Government's Agriculture, Food and Rural Communities Directorate which also undertakes crop inspections. The current system was amended in 2015 to meet European standardisation. The scheme can be called a 'flush through' approach where an official limit caps the number of generations produced of each class of potato ensuring older stocks are flushed out to protect against the multiplication of pest and disease. Minimum health standards for each class are maintained by inspection of the growing crop; officially inspected at least twice during the growing season.



**Figure 11: Scottish potato seed classification scheme (Source: SASA, 2015)**

The reasons why this seed certification method developed is clear and over the years has served the industry well but as markets move faster should it be revisited?

## 7.4 Geography as a Market Barrier

Geography, location and land type, affect market opportunities. Chile has a long history of growing potatoes. In 1834, Darwin noted the astonishing array of potatoes on the island of Chiloé, which is the genetic source of 90% of the world's varieties today. Further, Chile benefits from some of the richest soils I have ever seen with the advantage of long grass rotations and extremely high organic matter.

I met with Andres Vargas, the Chairman of the Chilean National Potato Association, on his farm in the Los Lagos region of Chile. He explained the challenges in the potato industry are not on the farm but in the country's geography – 'We may have the land but if we can't access the market there is limited opportunity.' (2019). Access to external markets is limited: the domestic market population is small, whilst oceans and mountain ranges add large transports costs to access any export markets. This transport disadvantage is exacerbated by the lack of investment in Chile's processing facilities which means limited facilities can process crops, to extend their shelf life for export.

Further, while Chile produces a range of high-value produce such as cherries, avocados and wine which require shipping containers to transport these goods to Europe and China, these containers arrive carrying high-value food processed goods, such as French fries, taking advantage of the low/shared transport costs and may compete unfairly with the Chilean home-grown potatoes. Being a heavy product, potatoes are costly to export. Chilean potatoes have to find their place in the home market.

Chilean growers are working together to support each other and share experiences. I met with a group of farmers in Puerto Varas where they had set up a grower group of around 12 growers which had been running for 10 years. They met once a month and walked each other's crops and went on study tours. While I was with them, they were organising the purchase of next year's seed. They had become not just a support network but also a buying group and helped each other plan for the future. The group were acutely aware of how hard the job was and how to minimise risk, planning ahead. I met with new members of the group who were using the potato crop as a steppingstone into other markets. Fillipe Figuero was one such group member who had invested in cherry production as this would bring his business far better returns given increasing global demand. This enterprise requires high levels of initial investment but he was able to use a potato crop, sold locally, to help him into this market by generating profit to invest.





**Figure 12: Cherries, Chile**  
Farmers moving into higher value markets for export



**Figure 13: Potato planting, Chile**

## 7.5 Niche Markets

I met with George R. Osure, Regional Director of the Syngenta Foundation for Sustainable Agriculture (SFSa) in Kenya, which aims to support the development of agriculture. With the largest, most diversified agricultural economy in East Africa, Kenyan agriculture occupies a central place in the government's developmental strategy. A major producer of tea and coffee, Kenya is also notable as one of the biggest exporters of fresh produce, such as vegetables, fruit and flowers, to Europe. In 2016, the agriculture sector contributed about 35% to the Kenya's Gross Domestic Product (GDP) and employed more than 62% of the total labour force (World Bank, 2018).

Kenya's total land area is about 587,000 km<sup>2</sup>, of which 18% has a high to medium agricultural potential. The rest is less suitable for farming, being defined as Arid and Semi-Arid Land (ASALs). About 3 million smallholder farming families account for 75% of the country's total agricultural production. The principal crop is maize (sometimes supplemented by potatoes, bananas, beans and peas), typically cultivated using limited technology on land often measuring no more than two hectares.

But challenges exist for agriculture in Kenya. Over the last 50 years, the population has increased more than fourfold, and now stands at approximately 50 million people. However, in recent years agricultural productivity has stagnated. This poses critical challenges to food security. Only about 20% of Kenyan land is suitable for farming, but maximum yields have not yet been reached in these areas. Smallholder farmers therefore have a vital role to play in improving agricultural productivity. However, they face a number of constraining factors. Farmers often lack access to adequate financial or extension services, leaving them vulnerable to vagaries in the market or to the impact of high losses caused by costly transportation or goods perishing in transit on poorly maintained rural roads.

Since 2009 the SFSa in Kenya has worked with partners to improve the crop yields and incomes of Kenyan smallholders. This work has focused on modern agricultural knowledge, soil management practices and facilitating access to markets.



Population increase and change in consumer demands is bringing economic opportunities to potato farmers in Kenya for the niche market of hand-cooked potato crisps. A consistent demand for hand-cooked crisps, which does not require large-scale investment in facilities, is providing growers with a secure market that they can rely on for income.



*Figure 14: George R. Onsure, Kenya, showing local potato production used for a local niche market for crisps*

Market demand and access to those markets determine the opportunities for potato growers. Growers who are able to track changes in supply and demand and can adapt their businesses have a clear advantage: finding supply chain tools to be able to share this information is critical for the primary producers. Sometimes access to markets is not only determined by market forces, as government policies can support or hinder trade.

**Summary.** Global and local potato markets are all changing fast, adapting to many pressures ranging from simply growth in local demand, changing consumer habits and the potato market finding its place in among the other product markets and transport systems.

The next chapter addresses the impact of government policies or lack of them.





## 8. Seed Potato Policy

Access to certified seed is limited by economics and by individual country trade and plant health policies. In current practice, certified potato seed use around the world is low, below 10%. Emerging markets such as India, Brazil and Kenya suffer from plant health policies which restrict the import of seed potato varieties – despite the fact that newly developed varieties often offer the grower a higher yield or protection from pest and disease.

### 8.1 Trade

Sub-Saharan Africa's growing population and global connections mean that its developing market is an opportunity for new trading channels for Scottish seed potatoes. Kenya's political influence and agreements with the East African Communities (EAC) of Rwanda, Burundi, Kenya, Uganda and Tanzania, a group of free-trade nations, are important as the EAC provides greater opportunities for countries with more advanced breeding programmes to access trade with Africa. Trade agreements which are set up with Kenya are then replicated through Africa with more ease, giving access to a huge market.

China's overseas policies grasping this opportunity are evident in Kenya. The foreign investment in infrastructure by China is apparent as you travel through the country. China has seven per cent of the world's land with 22% of the world's population to feed. Kenya's fertile land and plentiful water is being opened to international trading channels with Chinese capital investment. This investment in Kenya on road and rail networks involves huge construction projects designed to improve movements of people and goods throughout Africa. This is part of the Chinese Belt and Road Initiative, which connects China to food producing countries like Kenya, in a bid for food security.

Linking these circumstances to certified seed access, the potential for potato growers in Kenya would be increased by greater access to higher yielding varieties e.g. from Scotland. Increased connections to markets by investment in infrastructure makes for a prosperous future for both Kenyan and Scottish growers. Organisations such as the Kenyan Potato Council play a vital role in representing growers and promoting national policy that will help in the development of the sector as they support the education of farmers.

### 8.2 Global Partnerships

India is the second largest producer of potatoes in the world, and, like Kenya, this country benefits from areas with climates which allow for multiple potato crops to be grown in one year.

While in India, I had the privilege of being hosted by the Sangha family – the biggest seed producers in India. Learning about how this business operates was undoubtedly the highlight of my travels. This family business propagates and markets seed across India. I met merchants from Punjab to Bengal during my stay. Every day new customers would arrive, having travelled across the country to place their seed orders for the season. One of the challenges that became apparent is seed fraud. When a business invests in innovation and creates the highest of standards for their product it makes them a target for scams. In countries where limited regulation occurs on the ground and it is hard to police seed quality certification, the integrity of seed marketing can be majorly corrupted.



The vision of the Sangha family was to build a world-class potato business and their most recent project has been to build cold storage facilities to handle and store seed crops. They had secured funding from Innovate UK (a UK government funded non-departmental body) and have built world-class, research standard facilities. Applying pioneering storage research and using specialist equipment from Europe, they have created a centre for excellence in potato storage. This investment demonstrated best practice in a facility that can handle and sort crops in cooled conditions and store in boxes up to 2500 t in climate-controlled stores with the infrastructure to double this capacity. This is the most incredible feat of global collaboration led by a farming family, see details below. In the UK farmers have invested in cold storage to improve all year-round domestic supply; however, UK government capital funding and investment in storage research is very limited.

India's Innovate UK funding project aims:

*'As a major agri-food business operating in perishable fruits and vegetables the Sangha Refrigeration amongst other fresh produce businesses in India are currently facing high wastage levels and major operational challenges. This project involves Indian Partners Sangha Innovation Centre, Punjab Agricultural University (PAU) and the Centre for Innovative and Applied Bioprocessing (CIAB) and UK partners the University of Lincoln (National Centre for Food Manufacturing), Coveris Flexibles UK Ltd, FRPERC (Food Refrigeration & Process Engineering Research Centre) and ECH Engineering Ltd, working together to develop and optimize the fresh produce supply chain and related storage processes in India. Project activities will include the review, research and development of small (10 tonne units for small farmers and communities) and large-scale cold-storage facilities for fresh produce including potatoes and other fruit and vegetables.*

*Project benefits in India will include helping small farmers to improve their living conditions by preventing rapid value loss in their crops, allowing them to keep produce long enough to sell into higher-value markets. Some fresh produce, currently of sufficient quality only for use as animal feed, will as a result of this project, maintain high enough quality for human consumption, increasing availability of nutritious, efficiently produced fresh produce. These benefits will be achieved through introducing temperature control in a low-cost, energy efficient way.'*



Figure 15: Innovate UK storage project, India



Figure 16: Seed potato grading, India



### 8.3 Plant Health

Accessing seed and new varieties is a sensitive issue in many developing markets. Protecting a nation's plant health and opening access to imports is a highly politicised issue. I met with plant breeder Dr Elcio Hirano in Brazil, who I had first met three years earlier in Scotland. He was then part of an inward mission from Brazil to sign an equivalence deal to allow more accessible trade of seed potatoes to Brazil. During the deal's negotiations, testing facilities, protocols and inspections were discussed. When I went to Brazil, I was keen to learn what the impact of deals like these can have on the importing country and see first-hand the opportunities for Scottish seed in Brazil.

Brazil has an expanding market for potatoes given its huge population growth, Westernised diets and good access to other growing South American markets. I visited The Brazilian Agricultural Research Corporation (EMBRAPA) which was founded on April 26, 1973, and is under the aegis of the Brazilian Ministry of Agriculture, Livestock and Food Supply. Dr Hirano had managed their potato research based in Santa Catarina for over thirty years.

The EMBRAPA foundation have taken on the challenge to develop a Brazilian model of tropical agriculture and livestock to overcome the barriers that have limited the production of food, fibre, and fuel in Brazil.

For the Brazilian potato farmers, it is important to establish a thriving domestic commercial potato industry, balancing the mix of government-funded investment in new varieties specific for the market and climate while bringing in successful international varieties.



**Figure 17: 100 acres pre-basic seed field, Brazil**



**Figure 18: Mini tuber seed potatoes, Brazil**

Figures 18 and 19 : farmers, breeders and mini producers collaborating to scale up potato production across Brazil.



## 9. Technology and Innovation

During my travels I found a strong appetite for innovation and technology in the potato industry within emerging and developed markets. I attended the Global Potato Conclave in Gujarat, India, in 2020 and the Potato Expo USA in Las Vegas, America 2020. Both presented an opportunity to study the attendees' views on the future use of innovation and technology in the world potato industry. In this portion of my study, I expected to find clear solutions for improving connectivity in the potato supply chain.

### 9.1 India – Global Potato Conclave 2020

At the Global Potato Conclave I learnt that much of the production in India is at a grassroots stage and there arises a sense of ambition and opportunity to try some more radical approaches. In India, access to digital tools, modelling and programming, is affordable and in many cases local. Many examples of these programmes are being implemented for pest and disease modelling across the country sharing information from farms.

At the Conclave I met with researchers from the International Potato Centre (CIP) working with growers to establish a no-till potatoes production system. They were able to use rice paddies as a medium to grow the crop in and harvest it above ground. The reason for this novel approach was that they were looking at how to increase production across the country in areas where land is unsuited to root cropping systems. This no-till technique is sometimes discussed in developed markets however the rationale in Europe is from an environmental, soil degradation and PCN control point of view.

CIP researchers based their principles for developing a no-till system on what resources Indian growers had and what they would need to establish potato production in remote areas, those which traditionally had never grown potatoes. They were achieving good yields and an amazing skin finish, but finding suitable varieties was the next phase.

Potato breeding and variety development seems to be the biggest barrier to progress I can see. Clear frustration exists in the Indian potato industry as debates were had about policy interpretation which they see as a barrier to new varieties coming into the market. Farmers predominantly grow traditional varieties which are low yielding and susceptible to many pest and disease pressures. There is a lack of access to certified seed and widespread seed fraud, as mentioned in the previous chapter. Breeding programmes are controlled by the government and research organisations, with restricted movement of international varieties getting through the system. This can change but it will take time and investment from countries exporting to India to build relationships as the dynamics of the potato industry progress. Investment in larger processing plants and secure supply chain structures are likely to be a driving factor in bringing modern varieties to India. Examples of this were presented by the Dutch embassy who were supporting Dutch businesses in building potato processing factories and machinery manufacturing in India.





**Figure 19: Global Potato Conclave, India**

## 9.2 United States of America – Potato Expo 2020

In the USA there is a buoyant market, supported by an abundance of land and policymaking to access chemistry and technology. I expected to find the most innovative examples of new technology being used here. However, it seems that when you “have everything” there is less drive for growers to innovate. Saying this, there are pockets of amazing technology on the shelf ready to go and this provides great insight as to what the future of potato production could look like. The Potato Expo, the major event for the potato industry in the States, offers an opportunity for American potato industry – growers, researchers and commercial companies – to network and plan for the future.

Breeding programmes deployed in America are often based in academic institutes around many states. This creates some exciting programmes looking at novel approaches that embrace new technology. I learnt about one such example when I met Shelly Jansky, a research geneticist for the USDA ARS (US Department of Agriculture’s Agriculture Research Service), while at the Potato Expo. She hosted a discussion on the future use of hybrid potatoes. With advanced technology in genetic markers, traditional breeding programmes can return results much faster. With these developments, the industry can consider a move from haploid to diploid cultivars, a process which halves the chromosome numbers and makes breeding less variable. While this process makes it easier to select for preferred pest and disease traits it can result in reductions in crop yield. However reducing crop losses from pest and disease can compensate for potential loss in crop vigour. With time and improved application of this technology the yield potential is increasing while in conventional systems the costs of managing field pests and disease are increasing, as supported by the scientific literature:

*‘Potato has a variety of reproductive uniqueness’s besides its clonal propagation by tubers. These traits are controlled by a different kind of genetic control. The reproductive information has been applied to enable interspecific hybridization to enhance valuable traits, such as disease and pest resistances, from the tuber-bearing Solanum gene pool.’ (Wantanbe, 2015)*

While at the Potato Expo, I learnt that new breeding systems require governance, supply chain demand and public acceptance. It is important to design varieties which take account of the needs of the whole production network. Similar to the UK, varieties using advanced genomic methods are not



gaining commercial traction in the American market. There seems to be a lack of collaboration between researchers, growers and consumers which is slowing the uptake of this innovation.

New breeding technology is a thriving area in America as they have experience in other crops: The bulk of the seed potato trade involves genetically identical clones produced in large numbers by planting pieces of potato stem, or tuber, or through tissue culture. But another route would be to use “true seed” collected from the berries of the potato plant. This approach brings the benefits of making potato seed much more agile/resilient than when transporting seed potatoes as tubers. True seed brings huge potential to the seed potato system and could be the most exciting development in future potato breeding. It can be used to encourage genetic diversity in the field and provide natural protection to predators because each seed is genetically unique (essentially a new variety). For this technology to be applied a complete change in management approaches (discussed below) will be needed as True Potato Seed (TPS) is often dismissed because it does not fit the systems which have been in place for generations, the yields are perceived to be lower and the crop which is grown will have genetic variance.

Nevertheless, different applications of potato seed technology exist, especially in areas where there is opportunity to increase consumption and land availability. One would be to accept the genetic variance which creates crop management challenges. You cannot consider the potato field as being uniform and a best approach would be to precision manage each plant to its own requirements. Lots of tools are available which, with some application technology development, would allow variable plant management. The benefit of this precision approach is that you create a field with much more resistance to natural predators and less reliance on chemical control. Another approach is to move to diploid seed which is more uniform but can reduce total yield.

### 9.3 Digital Solutions

*‘Technology solutions are fragmented, complex and costly’ (Madhu Jamallamudi, Agrometrics)*

Madhu Jamallamudi has worked in the American potato sector for many years. He has established his business, Agrometrics, to use technology to connect producers in order to shift the farmer-supply chain relationship to an empowered strategic position. Madhu designed and built an online portal for the seed potato industry to develop an Amazon-style marketing system. He is using block chain, big data and machine learning, to send real-time information back to growers to allow them to make in-field management decisions to manage their crop for the market. This can be as simple as taking factory production information and relaying it back to harvester operators on, for example, the level of bruising in the crop (damage to potatoes) in an automated process.

Agrometrics’ business has been developed in the USA primarily to support large, progressive businesses in developed markets. I was pleased to meet Madhu Jamallamudi at the Global Potato Conclave and the Potato Expo in America. He told me that his business services were delivered from India and America. In India he was able to employ a team of data experts to process data. It became apparent that there were quite a few digital food production tools being built in India using Indian expertise, at lower costs, which could be applied to any type of farmer in developed and emerging markets.



This use of IT has been enabled because the IT industry has played a significant role in enhancing the Indian economy, as well as putting India on the global map. The Government of India has launched several policies for the development of science and technology (e.g. Science Technology and Innovation Policy 2020).

The fact that India is home to a large English-speaking talent pool is reason enough for global IT companies to strengthen their relations with India. In a move beyond outsourcing, development centres and R&D units in India are being established. Agriculture is just waking up to the potential of this data-driven decision, making support tools to advance food production, and India is leading the way and making this an affordable tool for farmers around the world.

The key in making this digital platform really work was knowing what information was available, how this could enhance management decisions and then, most importantly, making it easily understood by the end user.

Due to the highly skilled and high-risk nature of potato growing, technology development will remain at the core of the industry. To successfully manage pest and disease threats, boundaries cannot be drawn around an individual plant, field, farm or nation, and therefore collaboration will be paramount.



## 10. Discussion

Nine lessons learnt from my above journey are:

**10.1 Marketing connections.** The potato is a crop that can be high risk and can involve high costs to growers. However this seems to bring resilience with it as the mindset of anyone working in the agricultural sector needs to be flexible. I met with people throughout my Nuffield travels who demonstrated that intelligence and talent can be developed and strengthened. People are building connections to the environment, to knowledge and to people in order to establish strategic partnerships to strengthen their businesses.

**10.2. Environment.** The environments that potatoes are grown in around the world are ones of huge contrast. However, there is an understanding by all farmers that the ground and natural resources that produce food need to be protected. Potatoes are a crop which offers a low carbon footprint and water efficiency for high nutritional value. Some exciting regenerative and sustainable systems, like Muthome's circular systems on a small parcels of land in Kenya, are being used in each country I visited, that will underpin the future of potato systems globally.

**10.3 Social and education.** Potatoes have a long history supporting rural communities, as a crop with high potential for creating revenue and bringing jobs with it. Skills training and education are key to develop the people involved in potatoes. The skills required are incredibly diverse globally and, as systems evolve, skills training is going to be in high demand.

**10.4 Joining up the production chain.** Strategic partnerships strengthen the seed supply chain. Throughout the industry, collaboration between science, growers, processors and customers, raises seed potato standards and variety in satisfying potential end uses. Also, as more is understood and shared throughout the supply chain about the potato crop, more of the risk associated with the potato can be managed.

**10.5 Market access.** Access to market is the most vital factor in any production system. The value of connecting to customers cannot be underestimated. Whether that is a seed purchaser, processing facilities or a consumer, the tyranny of distance is unfavourable to the potato. In the UK there is a consumer market many are envious of: 67 million customers with relatively high disposable incomes; however, there is a disconnect between the growers, consumer, researchers and government that needs urgent action.

**10.6 Regulatory controls.** Policy to protect national plant health and food standards is needed for a successful domestic seed supply chain. No standard approach exists globally and this can distort the progress of plant breeding and developing the viability of the potato crop. If plant health standards can be aligned, with support from governments, the potential for seed potato exports would grow exponentially.

**10.7 Use of technology** Fast paced progress in technology and innovation, with developments wider than just agriculture, can offer the potato supply chain some exciting opportunities for innovation. For instance, market disrupting technology like zero tillage systems that will not be





accepted universally yet give potentially large advantages to early adopters. Current UK production systems are multi-level and complex, where produce is handled by many different stakeholders over a few years, and, if technology is being introduced, it needs to reduce risk and consider reducing the complexity of crop management. Businesses offering services in this sector need to focus on simplification, not over burdening food supply chains with more process. The application of technology must consider the whole crop cycle, from field to fork to identify real gains.

**10.8 Producer protection.** New breeding technology and true seed innovation is progressing and there needs to be a mechanism in place to protect the primary producer. Information sharing and leadership from growers and governments will be needed in applying these new technologies which will potentially cause transformation in potato production. The conversation between science, growers, governments and consumers needs to have already started.

**10.9 Seed supply systems.** The Scottish seed industry can lead change in how seed supply systems operate in the future by understanding current practice and implementing the most advanced technologies to better link production with consumer expectations.



## 11. Conclusions

- The potential of the potato as a global food staple has not been fully recognised.
- Deployment of technology which is emerging in other industries needs to be adapted to help tackle the challenges of the potato sector
- There are many tools and technologies that businesses can adopt to enhance communication in the supply chain.
- There is variable uptake of technology and innovation globally.
- Information needs to be shared up and down the supply chain to form strategic partnerships.
- Global potato markets are full of opportunities for innovation and constantly expanding and change seed potato supply chains.
- The UK has complex supply chains which are technically detailed compared to others and simplification is required.
- Chains, from seed production to the food consumer, are often linear not circular. Systems that are circular have advantages in sharing insight.
- Transportation of potatoes remains a barrier to progress.



## 12. Recommendations

- Focus on the quality of seed through multi-generations of seed stocks to reduce waste, and thus improve sustainability practices.
- Bringing seed producers closer to consumer trends, i.e. a whole industry approach.
- Industry collaboration to move from linear to circular in structure – reduce the UK industry gap between science and the consumer.
- Identify the leading role the Scottish potato industry takes in shaping the future of global potato production to establish a grower-led association to protect the reputation and progress of Scottish seed potatoes.



## 13. Next Steps After my study tour

The UK potato industry is facing many challenges and leading disruptive change since I have returned from my travels. Brexit and Covid-19 have brought new pressures to growers' businesses. The way people communicate and share information has evolved rapidly and this brings fresh opportunities for the agricultural sector.

My various roles working in the potato industry have always allowed me to ask questions in search of answers. Meeting a broad section of people from the agricultural industry has enabled me to bring back knowledge and work with people to develop ideas and innovation for the Scottish potato sector.

Having completed my Nuffield study I believe I now understand the value of these questions and the exchange of knowledge. Throughout my trip I was privileged to meet some incredible minds and had the opportunity to ask many questions. The value of someone challenging my thought processes guided me to come away from this experience asking more of myself.

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