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End to end automation of field scale vegetable production, incorporating data driven solutions

Written by:

Jamie Lockhart NSch

July 2025

A NUFFIELD FARMING SCHOLARSHIPS REPORT

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Royal Norfolk Agricultural Association

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

Date of report: July 2025

Title	End to end automation of field scale vegetable production, incorporating data driven solutions
Scholar	Jamie Lockhart
Sponsor	Royal Norfolk Agricultural Association
Objectives of Study Tour	To explore available and developing solutions that automate existing manual tasks in the production of root vegetables. The study tour looks at both in-field and in-factory solutions and investigates the barriers that prevent adoption and development.
Countries Visited	New Zealand, Australia, Denmark, Czech Republic, UK.
Messages	• Early alignment between technology developers and end users is critical. • The "come back to me when it is working" attitude will leave many game changing innovations on the drawing board. • Collaboration and commitment across the supply chain will drive real change and encourage innovation and the development of new ideas and technologies

EXECUTIVE SUMMARY

My report documents the transformative journey undertaken at Frederick Hiam Ltd in Suffolk - a UK-based root vegetable producer - through a bold pursuit of automation and digitisation, within the niche yet vital domain of parsnip processing. What follows is against the backdrop of escalating labour costs and declining availability, this innovation journey emerged from necessity but matured into a model of an industry first.

In 2021, as a company we faced a critical turning point. Manual labour shortages and soaring wage costs, exacerbated by Brexit and COVID-19-related constraints, threatened the sustainability of our processing operations. The nightly bussing of temporary workers from London for the parsnip line was both logistically impractical and financially burdensome. Something had to change.

Having been awarded a 2020 Nuffield Farming Scholarship, I used this opportunity not just to travel and study global trends but to drive real-time change within the business. This report details our decision to become an early adopter of emerging agricultural technology - culminating in a world-first fully automated parsnip trimming line, designed in collaboration with Wyma Solutions of New Zealand and the UK.

Beyond mechanisation, this report also explores the digital integration of core business processes, notably the modernisation of the weighbridge system via a partnership with Select Software. A once-analogue asset was transformed into a real-time, connected information hub, showcasing the broader applications of “Internet of Things” (IoT) technologies within agricultural contexts.

The outcomes of this journey have been profound. As a business we have not only reduced our dependence on manual labour but also doubled processing output, mitigating labour cost volatility, and, we feel, have positioned ourselves as a technological leader within UK horticulture. It has also laid a foundation for future innovation, such as the INSPeCT project aimed at improving post-harvest quality of parsnips and carrots.

Through strategic risk-taking, collaborative innovation, and a refusal to accept traditional constraints, Frederick Hiam Ltd has turned a pressing operational problem into a story of agricultural reinvention.

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DISCLAIMER

The opinions expressed in this report are those of the author alone and not necessarily those of the Nuffield Farming Scholarships Trust, of the author's sponsor, or of any other sponsoring body.

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CHAPTER 1: INTRODUCTION

Agriculture, like many legacy industries, is facing a crossroads—challenged by labour shortages, environmental mandates, and demands for increased efficiency. Within this shifting landscape, root vegetable producers face unique operational difficulties due to the seasonal and manual nature of their crops. Among the most labour-intensive is parsnip processing, which has long relied on significant human input for sorting and trimming. This report chronicles how we - Frederick Hiam Ltd - chose not only to confront this challenge but to completely reimagine how we operate.

Located on the Norfolk/Suffolk border, Frederick Hiam Ltd has been growing root vegetables, onions, and potatoes for generations. In January 2021, I joined the company as Managing Director, this change in leadership allowed and necessitated a review to the company's operations. Frederick Hiam is a business that was both proud and strained: proud of its produce but burdened by rising labour costs and a precarious dependence on agency staffing.

Shortly after stepping into the role, the business was faced with a sharp reality. During the peak processing period, labour shortages became so acute that the only available night shift workers had to be bussed in from London—a logistical feat that came at the staggering cost of £1,000 per night just for transport. Meanwhile, the UK's National Living Wage has increased by nearly 50% since 2019. Payroll pressure mounted, and the company's ability to absorb these costs was rapidly eroding.

Traditional responses - more recruitment, increased incentives - were no longer viable. We had to innovate or risk contraction. Fortunately, my Nuffield Farming Scholarship awarded in 2020 allowed me to study international best practices and take a different approach, creating a platform for active experimentation and adoption. I was lucky enough to undertake some initial travel to Australia and New Zealand in early 2020, prior to the Covid 19 outbreak. Despite not realising it at the time, a chance encounter with a New Zealand based agri-tech firm, Wyma Post Harvest Solutions proved pivotal. After a candid discussion about upgrading the company's manual trimming line, Wyma UK shared a prototype of an automated trimming system. This glimpse of innovation ignited a partnership that would evolve into something groundbreaking: the world's first fully automated parsnip line.

However, automation was only one piece of the puzzle. True transformation required integrating data and systems across the business. Enter Select Software, a UK-based tech firm with experience in smart city networks. Together, the teams embarked on digitising core infrastructure - most notably the weighbridge

system - transforming it from a paper-based tool into a cloud-connected, ERP-integrated platform for real-time logistics and inventory control.

What began as a necessity has since become a beacon of what's possible when tradition meets innovation. This report is not just a case study in automation, but a narrative of strategic vision, collaborative execution, and a willingness to step into the unknown.

Figure 1: The author Jamie Lockhart pictured whilst travelling in New Zealand (Rakaia River, Mount Hutt). Photo: author's own.

CHAPTER 2: BACKGROUND TO MY STUDY SUBJECT

I was initially awarded my Nuffield Scholarship in 2019 and at that time I was Director of Farming at Honingham Thorpe Farms close to Norwich in Norfolk.

The business was a large, mainly arable-based business. During that period, we were looking at digitalisation across the farm and how we could utilise data across the businesses to improve efficiencies. We had encountered many frustrations on that journey, largely to do with the compatibility of systems and the lack of integration between hardware and software developers.

My original subject therefore was around this and in February 2020 I set off in search of answers and to learn how other countries were tackling the move to a more digital world.

I go into more detail of my travels in the next chapter, but when Covid 19 struck and many things changed, including my career path and study topic.

Having returned from my travels in March 2020, I had taken on a non-executive role at Frederick Hiam Ltd. This is a large farming business specialising in root crop growing and packing for a variety of wholesale and retail customers.

Six months into this role the opportunity arose to take on the position of Managing Director of Frederick Hiam Ltd. Although it was a difficult decision to leave Honingham Thorpe Farms after 16 enjoyable years, the challenge of this new opportunity was too compelling.

In terms of my Nuffield subject, although the original topic was still relevant, I wanted to steer it towards the very real challenge we faced within the business and the solutions we needed to find to remain viable, therefore I changed my Nuffield title to *End to end automation of field scale vegetable production, incorporating data driven solutions*.

This allowed me the time and headspace to deep dive into researching a very real-time problem that has had a positive impact across the wider business.

CHAPTER 3: MY STUDY TOUR

As with all 2020 scholars we had some unique challenges to deal with when it came to the study tour itself.

Scholars from around the globe gathered for the Contemporary Scholars Conference (CSC), which, in 2020, was held in Brisbane, Australia.

We gathered in Brisbane on 12 March 2020 before taking a ferry to Tangalooma Island, a beautiful destination and the venue for the opening CSC conference.

However, headlines reporting incidences of Covid 19 outbreaks were growing and things escalated quickly. I made the decision to leave the island on 14 March along with a few other scholars. The next day all the New Zealand scholars were forced to return home. The conference did continue, but it quickly became apparent that an international lockdown was likely, and our travel plans would be put on hold indefinitely.

However, unlike most of the other scholars within my year group, I had been lucky enough to spend the previous six weeks travelling across New Zealand and Australia.

By coincidence 2020 was the year we travelled to New Zealand for our year group's 10th annual reunion of The Worshipful Company of Farmers advanced business management course.

This was hosted by Desiree Reid, a New Zealand Nuffield Scholar, who at the time of the course was dairy farming, but 10 years later had just opened the first whisky distillery in the South Island based at Cardrona. Little did I know it at the time, but it was meeting Desiree's father Alvin that had the biggest impact on my scholarship and my outlook to problem solving.

At the time of travelling my study topic title was *Unlocking the Potential of Data use and Agri-tech within Agriculture* and I visited many businesses across both New Zealand and Australia which shared the same frustrations as me. These were largely a result of 'being sold the dream' by tech developers that their latest innovation would revolutionise your business, only to find the reality was somewhat underwhelming.

This was mainly down to the incompatibility of systems to integrate, so although in isolation they would work very well, they rarely complimented existing technologies.

Subconsciously this stayed with me and when it came to developing the automated trimming line at Frederick Hiam Ltd. I understood the need for early engagement and collaboration with the developers to ensure they were working on the solution we needed as opposed to what they thought we needed.

This hands on approach to developing technological solutions was never more apparent than when I met Alvin Reid.

Alvin has been dairy farming all his life and I was lucky enough to visit his farm in Totara Valley, Pleasant Point in the South Island of New Zealand. Alvin had been an early adopter of robotic milking and what was noticeable as soon as I arrived on the farm was how calm things were.

Figure 2: Robotic milker in action. Photo: author's own.

The cows were quiet and had a level of autonomy about when they were milked, but also how they made their way through the process. There were races to guide them to the various paddocks etc, but no back gates of herdsman cajoling then into the parlour. It was a stress-free environment, the benefits of which were seen not only in milk yield, but also with veterinary and medicine savings.

Impressive as the dairy farm was, it was Alvin's continued involvement in the day-to-day running of the farm even though he had decided to move to Lake Wanaka, some 300 kilometres away, to help his daughter set up Cardrona distillery that really caught my imagination.

I had the privilege to sit with Alvin in his home on the banks of Lake Wanaka and witness him actively manage the day-to-day activities on the farm. As the image shows in a scene similar to the Starship Enterprise (figure 3), he was able to monitor the milking process, control gate access to various paddocks, transfer milk to different locations and basically do all that he could do if he was physically on site.

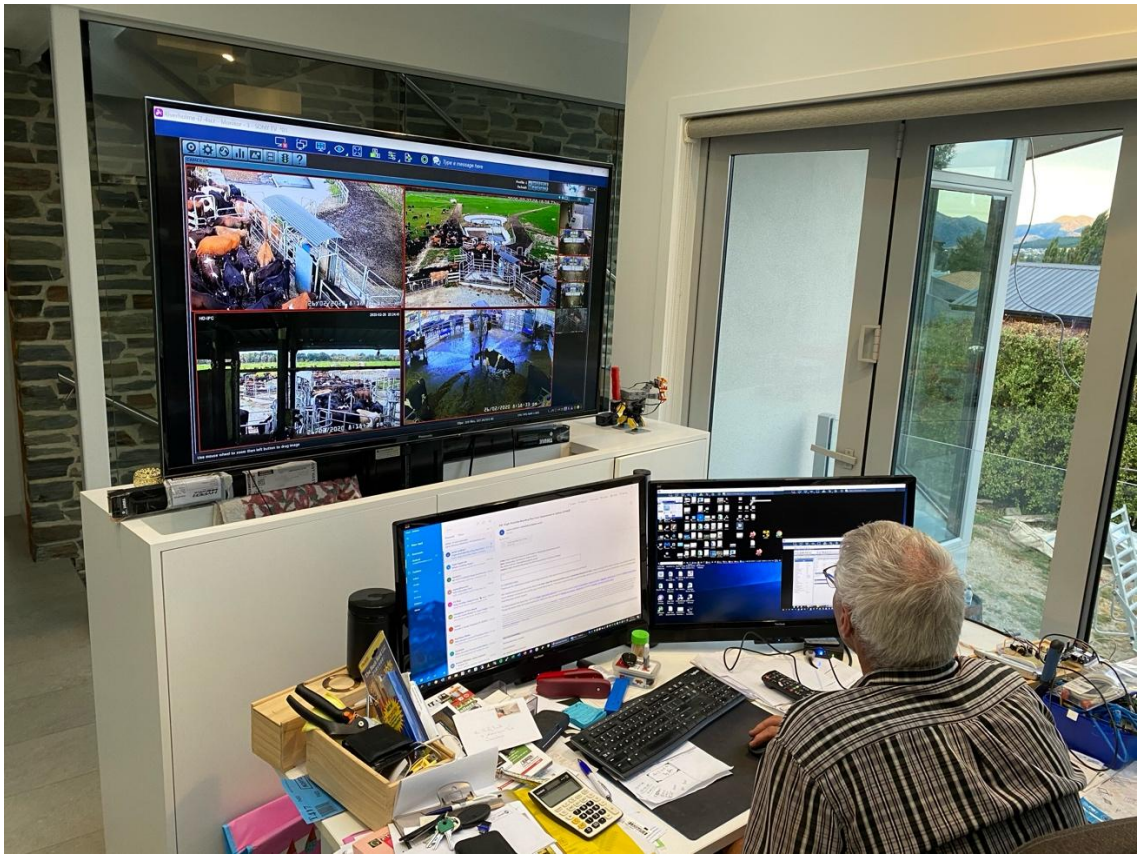

Figure 3: Alvin sat at mission control some 300 kms away. Photo: author's own.

He clearly had staff that could be called on if a hands-on problem arose, but this was rare, which meant more sociable hours for his team and a continued involvement from Alvin, without missing out on his daughter's dream of setting up the first whisky distillery in the country. This is the perfect example of how you make technology work for your situation and not just settle for the conventional approach.

Fuelled by the experiences I had gained whilst on my study tour, I developed a very different perspective to problem solving.

In my opinion it is vital that technology providers and end users interact at the earliest stage possible to fully understand the desired outcome.

The process of getting to this desired outcome will undoubtedly change from the initial concept, but the focus will remain on what is ultimately required.

What follows is an example of this collaborative approach and the outputs it has generated. I firmly believe that without the exposure to the pioneering businesses I met whilst on my Nuffield travels, I would not have had the open mindset to embark on this journey.

CHAPTER 4: IDENTIFYING THE PROBLEM

Identifying the Problem

In order to appreciate the scale and significance of the transformation at Frederick Hiam Ltd, it's essential to first understand the severity of the challenges that the business faced. While many sectors of agriculture have been touched by increasing costs and labour shortages, the parsnip processing line stood out as an especially pressing concern - a symbol of vulnerability in an otherwise resilient operation.

Labour: The Breaking Point

By late 2020, Frederick Hiam's parsnip line had become almost completely dependent on agency labour. The challenge was not just the quantity of people required, but the reliability and cost of sourcing them. During the run-up to Christmas, when demand is highest, the situation became unmanageable. A lack of available night shift workers in the local area led to the extraordinary decision to transport agency staff from London—over 100 miles away. This came at a cost of £1,000 per night for transport alone, in addition to the higher hourly rates needed to incentivise such workers to make the journey.

Even with this solution in place, the labour pool remained unstable and increasingly reluctant. The workforce was performing low-skill but high-importance roles: positively selecting and placing good parsnips onto trimming lines with speed and consistency. Although the task didn't require technical qualifications, it did demand attentiveness, speed, and stamina - qualities that became harder to find at a time when more appealing employment opportunities were widely available across sectors.

Figure 4: Original line showing the reliance on manual labour. Photo: author's own.

Figure 5: The nightshift. Photo: author's own.

The strain on the business was intensified by increasing legislative costs. Between 2019 and 2025, the UK's National Living Wage rose by 50% - a sharp increase with no sign of slowing. Payroll data highlighted the impact: in 2019, Frederick Hiam employed 109 staff at a total wage cost of £3.6 million. By 2025, even with a reduced headcount of just 93 employees, payroll costs had still risen to £4.2 million - an increase of £600,000 despite having 16 fewer staff.

Had the business not taken steps to innovate and reduce its reliance on manual labour, retaining the original 109 employees would have added an estimated £650,000 to the wage bill, bringing the total increase to a staggering £1.25 million.

Put simply, the situation was financially unsustainable without significant change.

Figure 6: The sharp rise in National Living Wage *(source: The Sun 30/10/24)*

The Technological Gap

With the problem clearly defined, the natural assumption might be to look to the global market for solutions. However, parsnips are a niche crop, and their peculiarities in shape, texture, and fragility make them particularly unsuitable for generic processing technologies. Mainstream agri-tech firms, while actively developing solutions for crops like carrots and potatoes, were unwilling to dedicate significant R&D budgets to such a specialised need - especially without a guaranteed return on investment.

This created a classic innovation impasse. Technology providers wanted confirmed commercial interest before investing, while producers wanted proven results before committing capital. Frederick Hiam Ltd found itself straddling both worlds: needing a solution, but unable to buy one off the shelf.

The result was a strategic inflection point. The company could continue limping forward - maintaining costly manual processes, struggling with recruitment, and watching profit margins erode - or it could take a calculated risk and lead the way in developing something that had never been done before.

Rethinking the Business Model

The leadership team at Frederick Hiam Ltd recognised that innovation was no longer a luxury - it was a necessity. The question was how to pursue it without compromising core operations. This required a mind shift: away from incremental improvements and toward fundamental rethinking. Could a company rooted in traditional crop farming also become a technology pioneer?

This was the moment when my Nuffield Scholarship came into sharp focus. While many scholars use the programme for international research, I saw it as a springboard for immediate, ground-level action. The scholarship gave me both the platform and the confidence to initiate direct discussions with innovation partners and to position Frederick Hiam Ltd not as a passive customer, but as a co-developer of agricultural technology.

It was this bold perspective that ultimately set the wheels of transformation in motion—paving the way for an international partnership, new prototype development, and a deeper reimagining of how agricultural value chains could function in a post-labour world.

CHAPTER 5: BECOMING EARLY ADOPTERS

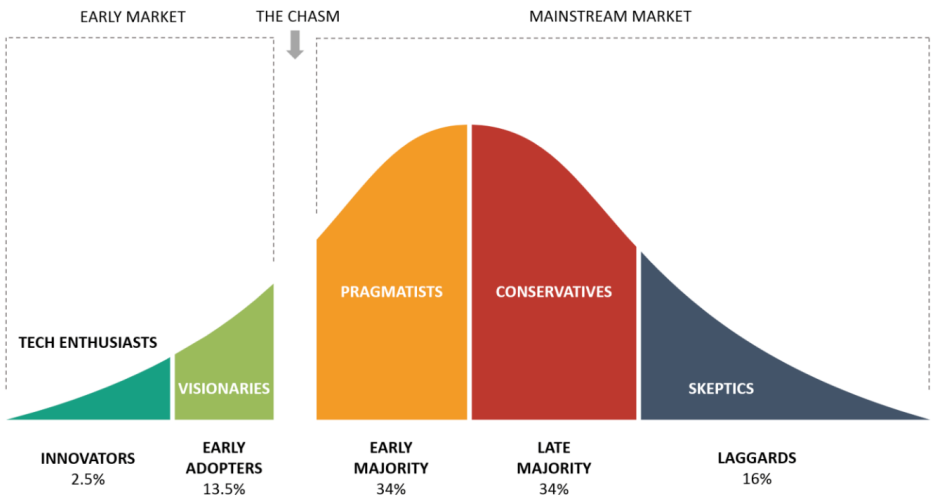

Figure 7: Early adopters - Crossing the chasm *(source Business to you.com)*

Innovation often begins where frustration peaks. For Frederick Hiam Ltd, the lack of available off-the-shelf solutions for automated parsnip processing became the very catalyst for bold action. Rather than continuing to search for a solution that didn't exist, the business chose to help create one. This section explores how the company embraced its role as an early adopter and co-developer - entering into a groundbreaking collaboration that would culminate in a world-first technological achievement.

A Familiar Connection, A New Opportunity

In 2020, during the initial stages of the Nuffield Scholarship, I visited several international operations, including Wyma Post Harvest Solutions in New Zealand. Wyma was known for its expertise in designing post-harvest machinery tailored to root vegetables, and their professionalism and innovation left a lasting impression.

Fast forward to early 2022, as labour issues mounted and the need for change became critical, that connection proved fortuitous. I reached out to Wyma's UK office to inquire whether they could help optimise the existing trimming line at the Brandon facility. Wyma conducted a line survey, assessing both the technical limitations and the potential for automation. Just as they were concluding their visit, Wyma shared a short video clip of a trimming system they were developing - a prototype that had yet to be commercialised.

That clip changed everything.

The concept was ambitious but compelling: an automated trimming system specifically for parsnips. The idea that a machine could achieve accuracy, consistency, and throughput comparable to human workers - perhaps even superior - was exactly the breakthrough the business had been seeking.

Laying the Groundwork for Collaboration

Seeing potential in the prototype, we quickly moved to formalise its interest. A signed collaboration agreement was completed in early 2022, with clearly defined benchmarks for continuing development. This was not a passive investment; it was a performance-based partnership with rigorous expectations.

The terms were clear: if Wyma could meet specific technical milestones - such as trimming two parsnips per second consistently over a two-minute test window - Frederick Hiam Ltd would commit to purchasing the system. This conditional commitment gave Wyma the commercial assurance needed to allocate resources and accelerate R&D, while giving Frederick Hiam Ltd confidence that its investment would lead to tangible results.

This arrangement also highlighted the strategic value of early adoption. By working directly with the technology provider from the outset, the company had a hand in shaping the final product to meet its specific needs. It wasn't just buying a machine - it was co-creating a new standard.

Prototyping and Testing: Learning in Real Time

The first prototype, built and tested in New Zealand, was a proof of concept. It demonstrated the feasibility of automated trimming and validated the system's 95% accuracy rate - far exceeding the 70% benchmark of the existing manual line.

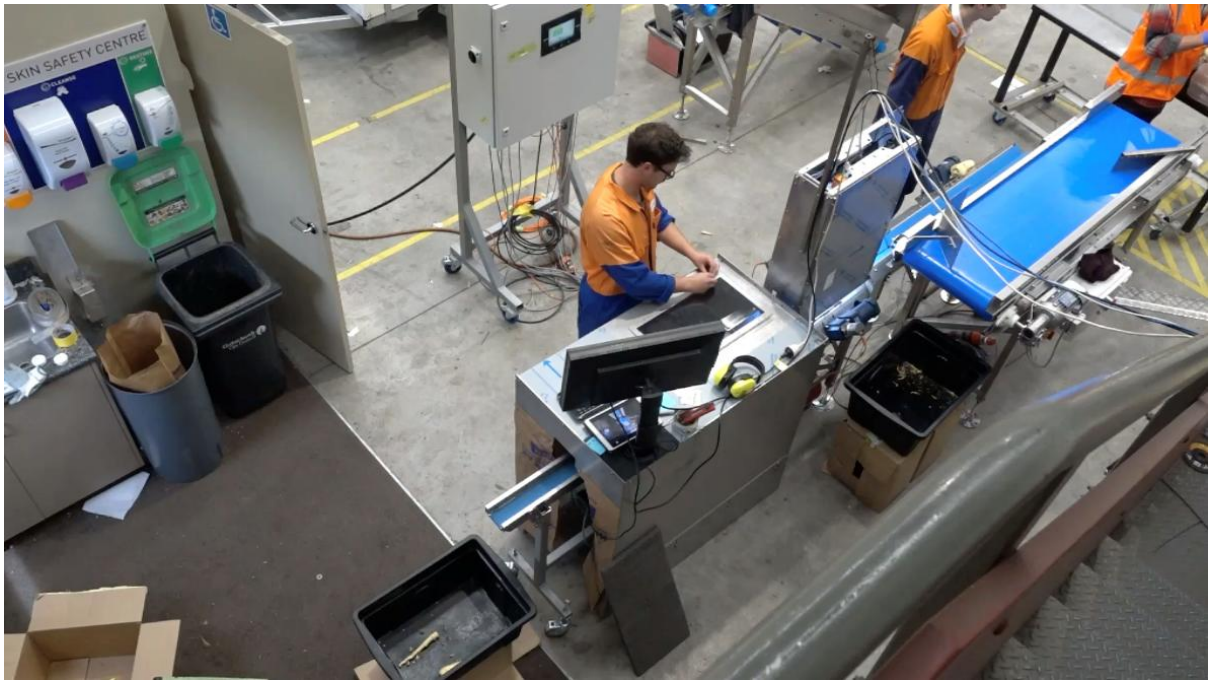

Figure 8: Prototype 1 developed in Wyma's New Zealand headquarters. Photo: author's own.

Encouraged by these results, a second prototype was constructed and installed at the Brandon facility in the UK, with Wyma's development team flown in from New Zealand to oversee the build.

This localised installation provided two key advantages:

1. **Access to raw material** – Being close to the supply of freshly harvested parsnips allowed for frequent and varied testing.
2. **UK factory conditions** – The machinery could be tested under real-world conditions, including variations in temperature, lighting, and crop consistency that are typical in British packhouses.

Importantly, the collaborative nature of the relationship paid dividends early on. During local trials, a flaw in the original design was identified - one that caused damage to a percentage of the crop. This issue, undetectable in controlled lab settings, was only discovered thanks to frequent interaction and feedback from the on-site team in Brandon. If left undiscovered until after full production, the error could have been costly and delayed the entire project.

This insight underscored the value of close, iterative development between end-users and technology providers. The goal was not perfection at first release, but continuous refinement through real-time learning.

Figure 9: Prototype 2 based at FH ltd site in Brandon UK. Photo: author's own.

From Prototype to Pre-Production

Before moving forward with the full-scale installation, Wyma had to pass one final test: the trimming system had to maintain performance by processing two parsnips per second for a continuous two-minute window—without manual intervention or failure. It was a high bar, but one that was achieved with confidence.

As an interim step, two commercial-grade trimmers were installed ahead of the 2022 peak season. This allowed for incremental performance improvements and gave the system's machine-learning algorithms more exposure to real-world variation. The data collected during this period proved invaluable, fine-tuning the system's decision-making and image-recognition capabilities.

By the time the full automated line was ready for commissioning, Frederick Hiam Ltd had already amassed months of operational insights—enabling a faster transition, more informed training, and higher confidence in the machinery's capability.

Reaching a Historic Milestone

By early 2023, the fully automated line was live. This was no ordinary machinery installation—it was a historic moment. Frederick Hiam Ltd had become the first company in the world to operate a fully automated parsnip trimming line. What began as a desperate search for labour alternatives had become a globally significant technological achievement.

Of course, the road wasn't entirely smooth. It took nine months of adjustments and iterative improvements before the system consistently met performance expectations. But once operational stability was reached, the impact was

immediate. The company entered into a processing agreement with another packing business, doubling site output without expanding its workforce.

This was more than success. It was vindication—proof that early adoption, when paired with collaboration and persistence, could transform not only a company's operations but also redefine what's possible in an entire sector.

Figures 10 & 11 show the transformation from manual to automated line in 18 months. Photo: author's own.

CHAPTER 6: IMPLEMENTATION OF AUTOMATED TRIMMING

Transitioning from manual to fully automated trimming required more than just the installation of machines; it demanded a complete re-engineering of how the business operated - from workflow design to staff training, from process monitoring to machine learning feedback loops. This section explores the technical architecture, operational rollout, and long-term implications of the first fully automated parsnip line.

Sorting the digital foundation out first

Before we could embark on any meaningful technological innovation, we first had to resolve our core technology foundations. This was a major undertaking, as we needed to maintain the company's workflow and revenue while simultaneously rolling out a completely new digital infrastructure.

With the expertise of David Aarons from Select Software, we successfully implemented an enterprise-level network across the whole site. A critical part of the process was ensuring that the existing, aging network systems remained operational throughout the transition. Once the new network was fully implemented, we were able to switch over seamlessly, maintaining all operational aspects of the business without disruption.

The risks were high, but thanks to a comprehensive planning phase conducted across the entire company before any cabling was installed, we were well-prepared. For the first time, we had a complete understanding of our system's pinch points and coverage gaps, which allowed us to significantly reduce the risk of production downtime.

That planning paid off. On switchover day, all terminals and remote handheld scanners came online smoothly. The new Wi-Fi mesh network went live, and production remained fully functional. As Managing Director, the most important outcome for me was that the planning had delivered results.

Now, with a solid and reliable infrastructure in place, we were able to move forward confidently implementing automation and IoT devices not only within the factory but across the entire company.

From Manual Lines to Mechanised Precision

In 2021, Frederick Hiam Ltd's parsnip line required a large team of manual operatives. These workers were tasked with visually assessing, selecting, and aligning parsnips onto trimming lines - a repetitive, tiring, and labour-intensive task. The work was critical for quality control but offered no scalability, especially under increasing cost pressures.

The new automated system removed this bottleneck entirely.

The trimming line developed by Wyma featured high-precision optical sorting technology combined with robotic arms capable of executing complex cutting movements with minimal margin for error. Machine vision - using high-speed cameras and sensors - allowed the system to scan each parsnip, evaluate its dimensions and orientation, and then calculate the optimal trimming points in real time.

The benchmark for success was clear: match or exceed the accuracy of human operatives while increasing throughput and reducing headcount. During early tests, the system achieved 95% trim accuracy - far above the existing 70% average, demonstrating not only parity with but superiority over manual methods.

Intelligent Automation and Machine Learning

What set this system apart wasn't just the physical machinery - it was the integration of artificial intelligence and machine learning. As each parsnip passed through the line, image data was analysed and stored. The algorithm learned from its outcomes: adjusting its trimming decisions over time based on feedback from downstream quality checks.

This created a self-improving system that became more efficient and accurate with each passing day. Unlike human workers, whose performance may plateau or decline due to fatigue or turnover, the automated line grew smarter and faster - an advantage that compounded over time.

The company leveraged this machine learning capacity by running the system in parallel with experienced quality control staff during the early phase of deployment. Human reviewers flagged errors or inconsistencies, which were then fed back into the training model, sharpening the system's decision-making with real-world data.

Workflow Redesign and Staff Reallocation

Implementing such a revolutionary system required changes beyond the machine room. The workflow of the entire packing facility had to be re-engineered to support higher throughput with fewer people. This meant:

- **Redesigning material flow** to accommodate the faster pace of processing.
- **Integrating automated weighing and sorting stations** to keep pace with trimmed output.
- **Upskilling staff** - reassigning former line workers to machine monitoring, maintenance, and system diagnostics roles.

Rather than eliminating jobs entirely, automation allowed Frederick Hiam Ltd to reallocate labour to more valuable and sustainable functions. Workers previously involved in repetitive sorting could now focus on oversight, safety, and system optimisation - creating a more empowered and technically capable workforce.

Operational Challenges and System Maturation

Despite the promise of automation, implementation was not without hurdles. The line required a nine-month bedding-in period during which:

- Sensors needed recalibration.
- Environmental variables (e.g. lighting, humidity, produce temperature) occasionally interfered with accuracy.
- Software updates were issued to address mechanical idiosyncrasies and expand the machine learning dataset.

These challenges were expected. After all, no other company had attempted to fully automate parsnip trimming at this scale. But through persistent collaboration with Wyma, and frequent on-site testing, the team successfully ironed out issues.

By the end of this phase, the system had stabilised and began to deliver at the level originally promised - proving itself not just functional but cost effective.

Scaling Output and Increasing Capacity

Once optimised, the new line unlocked capacity that the business previously could not have imagined. With fewer operators and the ability to run extended shifts with consistent quality, the Brandon site became a prime candidate for external processing contracts.

Frederick Hiam Ltd entered into a formal agreement to process parsnips on behalf of another packing company - effectively doubling its throughput without additional headcount. This shift turned the capital investment in automation from a defensive measure into a growth-enabling asset.

It also marked a fundamental change in our business model: from being purely a grower and packer, to becoming a technology-driven processing hub capable of serving wider industry needs.

CHAPTER 7: DIGITISATION AND INTEGRATION: THE WEIGHBRIDGE REVOLUTION

While the automated parsnip trimming line represented a breakthrough in mechanisation, it was only one piece of a broader transformation. Innovation did not stop with machinery - it extended to systems, data, and how information flowed through the business. A prime example of this holistic approach was the overhaul of the company's weighbridge system, a core operational asset that was reimagined using digital infrastructure and Internet of Things (IoT) technologies.

A New Perspective on Old Infrastructure

The weighbridge is a fundamental tool in any agricultural supply chain. Used to weigh incoming and outgoing produce, it plays a vital role in logistics, stock control, and billing. However, like many such assets, it had remained largely analogue - reliable in function but disconnected from modern information systems.

Traditionally, weighbridge data was recorded manually or printed out, often stored physically and processed later. This created delays in accessing key information, limited the ability to track trends in real time, and introduced opportunities for human error.

Recognising this as a missed opportunity, Frederick Hiam Ltd sought to repurpose and digitise this legacy system - not by replacing it, but by connecting it.

A Chance Encounter Sparks Innovation

The catalyst for this change was a fortuitous meeting with David Aarons, founder of a local business called Select Software. Based just 20 miles from the Brandon facility, Select Software specialised in smart city technology - particularly in mesh networks and IoT solutions.

The conversation was simple but profound: could existing agricultural infrastructure be digitised using principles normally applied to traffic systems, street lighting, or environmental monitoring?

The answer was yes.

Digital Transformation of the Weighbridge

Working in partnership with Select Software, the weighbridge was transformed into a smart node within a wider digital network. This wasn't just a software upgrade; it was a modular, integrated solution that delivered end-to-end data connectivity:

- **RS232 Interface Module** – A custom-designed interface linked the legacy serial output of the weighbridge to a modern digital gateway.
- **Secure TCP/IP Connection** – Data from each weighment was transmitted in real time to a centralised server via secure internet protocols.
- **E-Tickets with Camera Integration** – Existing CCTV cameras were configured to capture images of every vehicle or trailer being weighed. These images were automatically embedded into the weighbridge tickets, providing a visual record of every transaction.
- **Email and ERP Integration** – Data was automatically emailed to stakeholders and fed directly into the company's Enterprise Resource Planning (ERP) system, eliminating paperwork and delay.

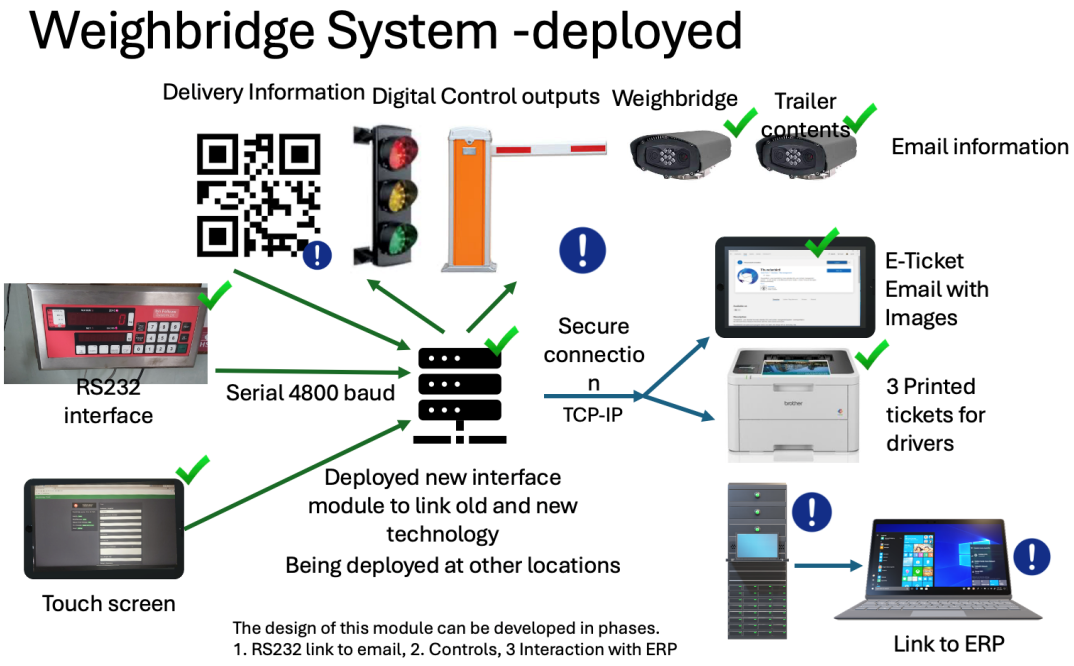

Figure 11 Image: author's own

The system was designed to be **scalable** and **phased**:

1. **Phase 1**: Link RS232 to email and create printable tickets.
2. **Phase 2**: Introduce remote control outputs for process triggers.
3. **Phase 3**: Full ERP integration for seamless logistics and accounting.

What began as a siloed, paper-heavy process became a digital touchpoint that improved traceability, reduced administrative burden, and enabled real-time decision-making.

Designing for Transferability

A major strength of the weighbridge digitisation project was its modular architecture. Once the interface was developed and proven for one asset, it could be replicated across others with minimal additional cost. The same principles could apply to:

- Cold stores
- Packaging lines
- Irrigation systems
- Harvest monitoring equipment

This approach aligns with the concept of a "digital farm" - a network of smart devices communicating through a unified platform, each feeding data into a dashboard that offers full operational visibility.

Rather than requiring massive capital investment, the solution demonstrated how **existing infrastructure** could be enhanced through **clever, low-cost interventions**.

Cultural Impact and Operational Buy-In

Just as important as the technology was the human element. By involving staff in the testing and rollout phases, the business ensured strong buy-in and smooth adoption. Teams quickly saw the benefit of having instant access to weighbridge data and digital tickets, particularly when resolving queries or managing deliveries.

This cultural shift - from analogue to digital, from reactive to proactive - reflected a broader transformation within the organisation. Frederick Hiam Ltd was no longer just a grower reacting to change; it had become a proactive developer and integrator of innovation.

CHAPTER 8: MEASURABLE IMPACTS

Innovation is only as valuable as the outcomes it delivers. For Frederick Hiam Ltd, the investments in automation and digital infrastructure were not speculative or cosmetic - they were strategic necessities with measurable results. This section explores the quantifiable impact of the transformation, highlighting both operational and financial benefits that have positioned the business as a leader in 21st-century agriculture.

Labour Cost Reduction and Stabilisation

Perhaps the most immediate and tangible benefit of automation was the reduction in dependency on manual labour - particularly in high-pressure periods like the pre-Christmas peak.

The previous payroll scenario:

- **2019**: 109 staff, £3.6 million in payroll
- **2025 (projected)**: 93 staff, £4.2 million in payroll

At face value, the payroll increase of £600,000 despite a headcount reduction might seem like a loss. However, had the business done nothing and retained those 16 additional workers, payroll costs would have surged by an additional £650,000 - pushing the total increase to **£1.25 million**.

By adopting automation, the company avoided this unsustainable trajectory and instead reinvested the savings into technology, training, and system improvements. It was not just a cost-saving measure; it was a stabilisation strategy that shielded the business from the volatility of wage inflation and labour scarcity.

Productivity Gains and Output Growth

One of the most powerful outcomes of implementing the world's first fully automated parsnip trimming line was the doubling of site output - **without increasing staff numbers**. This was achieved through:

- Faster throughput from automation
- Continuous, fatigue-free operation
- Machine learning improvements that enhanced precision over time
- Reduced need for rework or quality rejection

This productivity gain enabled the business to sign a new processing contract with another packing company. The Brandon site became not only self-sufficient

but commercially attractive to external partners. In practical terms, this transformed a cost centre into a potential **profit centre**.

Operational Consistency and Quality Assurance

Prior to automation, quality assurance was heavily dependent on the attentiveness of human workers. Consistency varied by shift, individual, and even fatigue levels within the same day. The automated system, by contrast, operated with **95% trim accuracy** across every session - surpassing the **70% benchmark** of the manual process.

This improvement yielded:

- Fewer rejects or quality downgrades
- Better yield from raw materials
- Reduced complaints and customer returns
- Stronger brand reputation for reliability

In short, automation improved not only efficiency but also **product quality** - a crucial differentiator in competitive retail supply chains.

Digitisation Payoff: Weighbridge Efficiency

The weighbridge transformation may have seemed like a small project in the shadow of full-line automation, but it delivered outsized benefits:

- **Real-time data access** allowed the logistics team to make faster, more informed decisions.
- **E-ticketing and image integration** improved traceability and resolved disputes swiftly.
- **ERP connectivity** created seamless communication between front-line operations and administrative functions.

Cumulatively, these changes reduced processing errors, eliminated paperwork redundancies, and improved accountability. The return on investment came not just in time saved, but in improved confidence and operational transparency.

Cultural and Strategic Shift

While harder to quantify, one of the most profound impacts of this journey has been the cultural transformation within Frederick Hiam Ltd. The company evolved from being a traditional grower with legacy systems to an agricultural technology leader with a mindset of experimentation, problem-solving, and continuous improvement.

- Staff have been upskilled and empowered.

- Departments now think in terms of data flow, not just task execution.
- Leadership sees innovation as a core competency—not an optional extra.

This cultural shift underpins all the measurable gains and ensures that the company is not only prepared for current challenges but positioned for future resilience and growth.

CHAPTER 9: BROADER IMPLICATIONS AND FUTURE VISION

The innovations implemented at Frederick Hiam Ltd represent more than a single company's transformation - they offer a glimpse into the future of UK agriculture. By pioneering fully automated processing and integrated digital systems, the company has created a replicable blueprint for how niche crops, rural labour markets, and traditional infrastructure can evolve to meet 21st-century demands. This section explores the broader implications of this journey and outlines the strategic vision for what comes next.

Technology Transfer and Scalability

One of the most powerful aspects of the projects undertaken - both the trimming automation and the weighbridge digitisation - is their transferability. These solutions were designed not as one-offs but as frameworks that can be adapted across a range of contexts and operations.

For example:

- **The weighbridge interface module**, once developed, can now be used across any site with legacy RS232 systems, including those managing potatoes, onions, carrots, or even grain along with non-agricultural users.
- **The trimming system**, though initially designed for parsnips, offers architectural principles that can be adapted for other complex-shaped vegetables with a degree of post-harvest handling complexity.
- **The IoT infrastructure**, including telemetry and remote monitoring tools, can be applied to storage, irrigation, and environmental control - delivering data-driven insights across the value chain and developing mesh networks as individual devices act as connectivity hubs for other devices.

By investing in modular, networked technologies, Frederick Hiam Ltd has made it easier not only for itself but for peers across the industry to adopt similar efficiencies with lower entry costs.

The INSPeCT Project: Expanding the Innovation Pipeline

One of the clearest indicators of the company's long-term commitment to innovation is its involvement in the INSPeCT project (Improving Nutrition and Storage of Parsnips and Carrots). Launched with support from Innovate UK and other partners, this project aims to improve the post-harvest life and nutritional quality of root vegetables through better monitoring and control of storage conditions.

The project focuses on developing and deploying V2 probe technology, which includes:

- **A sealed gel battery**, capable of powering the system for eight weeks continuously.
- **Environmental sensors** that monitor temperature, relative humidity, eCO_2 levels, air pressure, and volatile organic compounds (VOCs).
- **Telemetry and communication modules** with BLE beacons and long-range data transmission.
- **LED indicators** for quick visual diagnostics on the condition of stored crops.

These smart probes provide growers with actionable insights that can influence storage decisions, reduce spoilage, and enhance product quality - contributing not only to profitability but also to sustainability.

The project involves collaboration among multiple stakeholders, including:

- Vegetable consultancy services (VCS)
- UKAgritech centre (UK ATC)
- Frederick Hiam Ltd (Select Software acting as a sub-contractor to FHL)

The INSPeCT project embodies the convergence of science, data, and farming in practical, results-driven applications.

The image below shows how we are able to maintain the colour, feel and nutritional value of the crop to extend shelf-life and allow further efficiencies in field and factory, by having a wider harvest window. This process could be the biggest single change to positively affect our business.

Figure 12: author's own

Agriculture and the Internet of Things

The work done by Frederick Hiam Ltd illustrates the real-world potential of the Internet of Things (IoT) in agriculture - not as a buzzword, but as a set of tangible, cost-effective applications. By treating infrastructure and assets as data nodes, the business has built a web of intelligent systems that provide:

- **Predictive maintenance** (e.g. on trimming machinery or weighbridge components)
- **Real-time analytics** (e.g. trailer loads, processing speeds, environmental conditions)
- **Remote monitoring and alerts**, reducing downtime and manual supervision
- **Traceability** that enhances food safety compliance and audit readiness

This level of digital maturity, once rare in mid-sized farming operations, is becoming a necessity. Consumer expectations, environmental regulations, and retailer demands increasingly require producers to demonstrate traceability, efficiency, and carbon accountability.

By moving early, we hope to have future-proofed our own business and contributed to redefining what modern farming can look like.

It is important to recognise the unique role the Nuffield Farming Scholarship played in this transformation. The scholarship gave me not only perspective but permission to step back, ask bigger questions, and take calculated risks. While many scholars return with ideas from abroad, this project exemplifies a more hands-on, action-oriented model: using the scholarship to initiate real-business change in real time.

This path - from Nuffield Scholar to first-mover, from farm to tech partner - offers a compelling narrative for how agriculture must evolve in the years ahead. It is no longer enough to grow good crops; today's agricultural leaders must also grow capabilities, grow partnerships, and grow systems that are resilient, adaptive, and sustainable.

CHAPTER 10: CONCLUSION AND ACKNOWLEDGEMENTS

Conclusion

By enabling the transformation of Frederick Hiam Ltd from a traditional root vegetable grower into a technology-enabled agribusiness, we hope it offers a powerful lesson for the wider farming sector: necessity can be a springboard for innovation, and leadership is often forged in times of constraint.

Faced with soaring labour costs, dwindling workforce availability, and inefficiencies in legacy systems, the team at Frederick Hiam could have opted for short-term fixes. Instead, we chose to embrace change - partnering with international technology firms, pioneering the world's first fully automated parsnip trimming line, and digitising analogue infrastructure like the weighbridge. These decisions were not without risk. They required investment, persistence, and a cultural shift in how the business approached both problems and potential.

But the rewards have been profound:

- Labour costs have been controlled and stabilised.
- Processing output has doubled without expanding headcount.
- The business has secured new commercial contracts, enhancing long-term viability.
- Legacy systems have been modernised, enabling real-time data capture and operational visibility.
- A future-facing innovation culture has taken root - supported by modular, transferable technology that can benefit the wider agricultural community.

Through the Nuffield Farming Scholarship, I have not only gained new perspectives but created real impact - turning insights into action, and problems into platforms for progress. This report has aimed to document that journey - not as a finished chapter, but as the beginning of a new story for agriculture in the UK and beyond.

The work undertaken here has implications far beyond parsnips. It is a model for how even niche sectors can lead global innovation when given the tools, the partnerships, and the courage to break from tradition.

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This journey would not have been possible without the support, insight, and collaboration of many individuals and organisations.

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To **David Aarons** and the team at **Select Software** - thank you for bringing cutting-edge urban technology into a rural setting and proving that great ideas know no boundaries.

To the **INSPeCT project collaborators** - James Fortune, Alex McCormack, David Aarons and Verda Fazlic - thank you for carrying the torch forward into nutritional optimisation and post-harvest excellence.

And, finally, to the entire team at **Frederick Hiam Ltd** - thank you for embracing change, supporting innovation, and showing what's possible when a business aligns its people, its purpose, and its potential.

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