Aotearoa Agritech Unleashed

DRIVING PRODUCTIVITY, SUSTAINABILITY & ECONOMIC GROWTH

An analysis of the impact of agritech on New Zealand's economy and the opportunity for productivity and export growth.

digitalnation.nz

Acknowledgements

Agritech New Zealand would like to acknowledge the following contributors:

Lead report coordinator and Agritech New Zealand executive director, Peter Wren Hilton.

Monica Collier and the team from IDC, Neha Ralhan, Emily Lynch and Shanon Singh for collating content from multiple interviews and reports included in this study.

Graeme Muller, Jacqui Wren Hilton and Andrea Molloy for report direction, reviews and multiple edits.

Peter MacIntyre and team from Sapere Research for economic modelling advice and literature review.

Ministry of Business, Innovation and Employment for review and policy input and the Agritech New Zealand Executive Council for industry analysis, consultation and feedback.

The many agri practitioners, CEOs, MPs, Government agencies, researchers, business people and investors that we spoke to for this report.

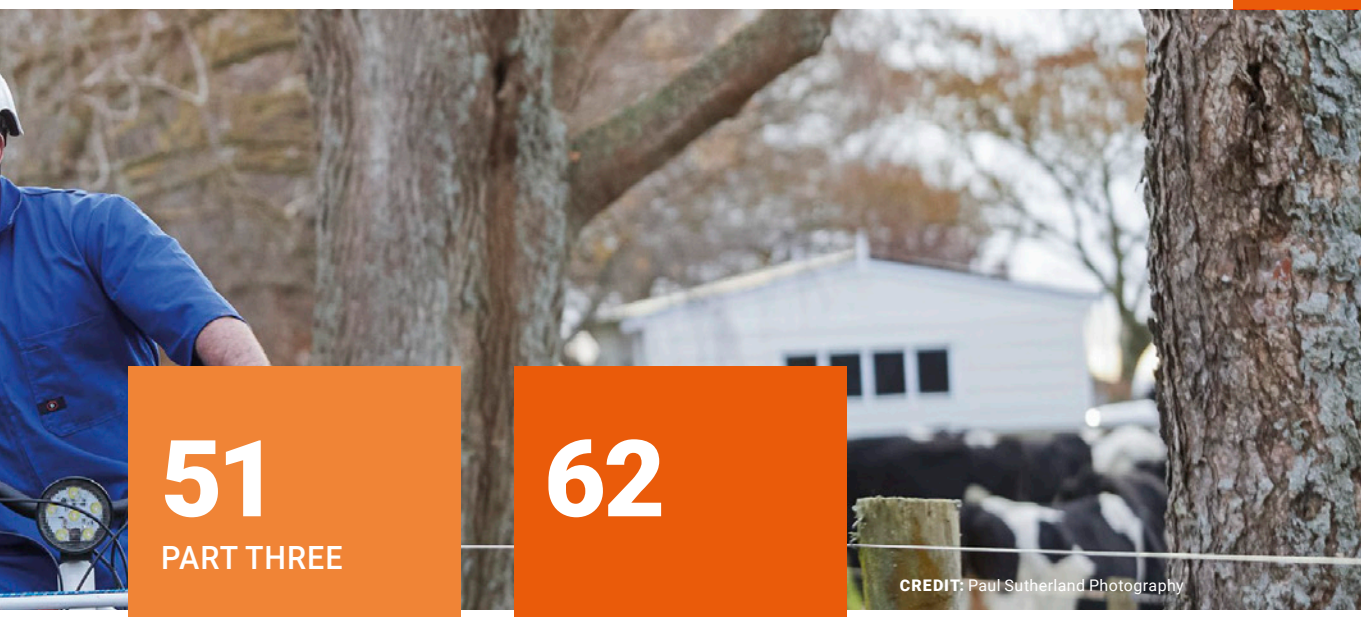
About Agritech New Zealand

Agritech New Zealand's vision is for a New Zealand that is a global leader in science, technology and innovation, delivering commercial outcomes for the world's primary sector.

Our purpose is to bring together the New Zealand agritech ecosystem to work together to unleash New Zealand's agritech expertise, globally and locally.

Agritech New Zealand is an inclusive, membership funded organisation with a broad range of active members who have a shared passion for the opportunities that agritech can bring. Agritech New Zealand advances the ecosystem through advocacy, collaboration, innovation, talent and economic growth through international connections and missions. We take a practical, but information and evidence-based approach, focusing on harnessing the opportunities and addressing the issues.

Contents



CREDIT: Paul Sutherland Photography

51
PART THREE

62

Unleashing Aotearoa's Agritech

Appendix

Tables and Figures

CREDIT: Paul Sutherland Photography

Thank you to our Project Partners

Project Partners

Agritech NEW ZEALAND

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Research Partners

IDC ANALYZE THE FUTURE

sapere research group

NZTech

Thank you to our Project Partners

With the Support of the Agritech New Zealand Members

ATS Geosuite • Connected Farms • Craige & Roz Mackenzie • Danz zappz.ltd (Fence Detective) • Fernbrook Consulting
Fraser Amtman • Gilbertson Associates • Harry van Enckevort • Haunui Technology Group
Hyper-analytics Research & Development Limited (HARDL) • MyEnviroOrchard Robotics • N J Hoogeveen
Plantation Road Dairies Ltd. • QLBS • Robert Auld • S D Walters • Sustainable Protein Ltd • Trusted Foods
Westfarms Ltd. • Willy Leferink • WKP Consulting Ltd

INTRODUCTION:
Agritech New Zealand

In February 2020, Agritech New Zealand joined a Callaghan Innovation led delegation to attend EvokeAG, Asia Pacific's premier agri food tech event.

Set against a devastating backdrop of Australian bushfires, drought, a broken food system and a degraded environment, the event highlighted our global interconnectedness. It showed the need for a system level reset of our food and agricultural practices and attitudes. Unknown to most, a reset catalyst was just around the corner with the arrival of the coronavirus, COVID-19. Surviving a pandemic was not on many business risk registers, however within months it halted travel and trade. More importantly, the pandemic implored us to reset our relationships with each other, our work and our planet.

The COVID-19 lockdown has accelerated the adoption of new ways of doing business and helped us harness the real power of technologies. While the full impact of the pandemic is still to be felt, New Zealand's reputation as a trusted democracy in the South Pacific is strengthening and demand for our produce is expected to accelerate. Coupled with global macro trends, for example, shifting demographics and changes in consumer preferences, the opportunities are ready for New Zealand to fully realise.

Critically, we are punching below our weight relative to our global peers. New Zealand's primary sector is large and growing yet our agritech exports are relatively small. Agritech businesses tend to solve domestic challenges and work competitively. However, what will move us forward is collaborative, cross-disciplinary thinking, and the convergence of skills and technologies. This is what characterises the emergence of all new sectors triggered by digitalisation. Whether it's fintech, creative-tech or govtech, coordination within a well functioning ecosystem which fosters connection across Government, industry and consumers creates true collaboration. Agritech is no different.

For this reason, Agritech New Zealand holds a vital role. Established in 2018, we are a purpose-driven, membership-funded organisation whose members share a passion for the opportunities that agritech can generate. The organisation provides a platform for engagement and knowledge exchange, both locally and globally. The Government strategy, the Agritech Industry Transformation Plan (ITP) was developed in collaboration with an all-of-Government agritech taskforce, encompassing seven Government agencies and Agritech New Zealand. This unique partnership is an excellent example of connected coordination and will play a pivotal role in New Zealand's future.

We live in extraordinary times. Agritech can continue to grow in its own right, developing high value export opportunities, sharing our unique New Zealand story and further diversifying the New Zealand economy for the benefit of New Zealanders, and the world.

FOREWORD:
New Zealand Government

New Zealand's agritech landscape is bursting with ingenuity.

New Zealand's agritech landscape is bursting with ingenuity, with many inspiring examples highlighted in this report.

Examples such as Gallagher, a long-established firm building on their proud history of invention going right back to the first electric fence. At the same time new start-ups like Biolumic and Robotics Plus are still at the beginning of what is hoped will be similar paths of innovation and success.

Simcro is creating ways to better care for our animals and protect their health, while researchers at Plant and Food Research develop new and improved crop varieties.

Tru-Test helping farmers collect data and information on their animals and their farms, while Figured helps farmers manage their information and farm smarter. Ravensdown is finding ways to make farming in New Zealand more productive and sustainable, while researchers at Argenta are reaching out internationally to solve global problems.

If we wish to make the New Zealand economy more productive, sustainable and inclusive - despite the significant impact on international trade and productivity Covid-19 has brought – we need to focus on areas of comparative advantage, where we have shown we can succeed with the best in the world.

newzealand.govt.nz

Hon Phil Twyford
Minister for Economic Development

The above examples and the domestic and export opportunities outlined in this report show agritech is one such area. It offers an opportunity for us to not only build on our historic strengths, but to meet the demands of the global market.

This reinforces the Government's focus on the agritech sector and the recent collaboration between government agencies and industry to create the agritech Industry Transformation Plan. The Government is investing $11.4 million to support the implementation of that plan and help us seize these opportunities for New Zealand.

I fully endorse the approach and recommendations of this report and look forward to seeing a fruitful and ongoing relationship between industry, government and research groups to further unleash Aotearoa's Agritech.

Executive Summary

New Zealand has a proud, rich agricultural history with an economy built on primary production.

In *Aotearoa Agritech Unleashed*, **Part One** explores New Zealand's agritech sector, its history of innovation, exports, COVID-19 and the global agritech landscape.

For more than 100 years, New Zealand's primary sector has been a world leading exporter of quality food. Our primary industry evolved with the advent of refrigerated shipping in the 1880s. Throughout time, New Zealanders have innovated across the primary sector bringing world first innovations to life to help produce better food. For example, the electric fence, gold kiwifruit and AI enabled smart cow collars.

Since the removal of Government subsidies in 1984, New Zealand agriculture has diversified. The traditional primary sector of wool, meat and dairy was supplemented with deer farming, wine production, honey and a broadening variety of horticulture. Farm numbers have decreased while land area per farm has increased and agricultural exports have shifted in favour of more processed, higher value products. New Zealand's food and fibre sector, including processing and commercialisation activities, contributes 11 percent to the gross domestic product (GDP).

In the post-COVID-19 era, agriculture is likely to continue to play a critical role due to the dramatic impact on other export sectors, like tourism.

New Zealand's broad based agritech sector supports all aspects of the country's agricultural sector, with over 950 agritech companies. While the agritech sector is spread throughout New Zealand there are clusters within regions such as farming in the Waikato, Palmerston North and Canterbury, horticulture in the Bay of Plenty and viticulture in the Marlborough and Hawkes Bay regions.

The agritech sector has continued to contribute a stable $1.1 billion to $1.2 billion in export revenues over the past five years to 2018, with the top 20 agritech exporters generating $803 million in exports in 2019. However, analysis suggests that New Zealand is underperforming, relative to its global peers. New Zealand food and fibre exports have grown substantially over this period and worldwide investment in agritech has increased by 36 percent per year. Consequently, both the small scale of agritech exports and the lack of growth are either a cause for concern, or a significant opportunity.

A Government Agritech Strategy

In July 2019, the New Zealand Government refreshed its approach to industry policy. The core of this new approach was the development of Industry Transformation Plans (ITPs) for select sectors of the economy, where significant growth opportunities exist. Agritech was selected as a priority sector because of its importance to New Zealand's transition to a highly productive, low-emissions future, its adjacency to a strong food and fibre sector, and existing expertise and investment in this area. The 2018 establishment of industry group Agritech New Zealand and their role as a cooperative partner with the Government was also an influential factor. The Government's ambition is to grow the agritech sector so it is better equipped to service both the domestic and international markets.

The aim is to grow the sector as an economic driver in its own right, with particular emphasis on high value export opportunities and further diversifying the New Zealand economy.

This Government strategy, the Agritech Industry Transformation Plan (ITP) was developed in collaboration with an all-of-government agritech taskforce, encompassing seven Government agencies, and the recently formed industry group, Agritech New Zealand. The ITP was launched in 2020, including an action plan and initiatives to grow the ecosystem, plus connecting it to global capital and markets.

Global Landscape

Globally, the adoption of technology in an agricultural setting continues to grow. Agritech is lifting the productivity of countries that were once traditional farming nations. It has also become a major export sector for many others, including Ireland, Israel, Netherlands, Singapore and the United Kingdom. In each country, resource constraints have driven innovation. The governments of each country have supported, encouraged or incentivised agritech adoption and market growth.

Now an industry in its own right, agritech is worth an estimated US$250 billion per year and is rapidly maturing. It is forecast to grow at a CAGR of over 18 percent through to 2025. Agritech companies are either digitalising manual processes, using technology to create new solutions or completely disrupting an area of agribusiness. This growth is driven by global megatrends such as increasing populations, changes in consumer demand and regulations for sustainability. These global mega trends are creating and driving new demand patterns, presenting both opportunities and risks for New Zealand.

The COVID-19 Impact and Opportunity

During early 2020, as the COVID-19 pandemic disrupted the world economy, the New Zealand food and fibre sector continued as essential services. The impact of the COVID-19 lockdown on the agritech sector was largely unknown until Agritech New Zealand surveyed the sector to gain a better understanding of the sector's resilience.

More than 50 percent of respondents identified that access to customers was their biggest business risk, specifically, decreased sales and cancelled projects. Another key concern was the impact on funding, with all startup respondents identifying it as a major risk. However, at the time of the survey 40 percent of respondents had taken advantage of the Government's economic recovery packages.

The impact and reliance on external suppliers, plus travel restrictions were also having a significant impact on agritech companies, with more than 50 percent identifying international travel restrictions negatively impacting their business.

The Agritech New Zealand COVID-19 survey provided timely new input into the Government's Agritech Industry Transformation Plan. While COVID-19 continues to have a major impact on the global economy, a strong demand for New Zealand food remains. It is expected new demand will accelerate, particularly in helping to address labour shortages and supply chain challenges.

Prior to the pandemic, global investment in agritech was growing and New Zealand now has a unique opportunity to take a larger slice of the global market.

The Economic Opportunity

High value export opportunities are not the only potential economic benefit of a vibrant New Zealand agritech sector. Local productivity gains

through better use of technology in the primary sector will provide the most significant economic opportunity. **Part Two** closely examines the economic opportunity of improved productivity.

Productivity is a key measure of performance and profitability on farms, forests and in the ocean. Its level reflects the efficiency of primary sector inputs; land, labour and capital to produce outputs.

The value of New Zealand's primary sector output, including agriculture, horticulture, forestry and fishing was almost $46.3 billion in the year to the end of March 2018. Estimates suggest that if a range of agritech solutions were fully applied across the New Zealand primary sector, output and productivity could be increased significantly. It is estimated that New Zealand's output could be around 21 percent or $9.8 billion dollars higher.

The estimate of $9.8 billion dollars greater output represents the value that could be achieved in the best case scenario of fully implementing agritech solutions. Subsequently, the question is how to apply the most promising technologies to help our primary sector increase its productivity for competitive advantage on the global market.

Aotearoa Agritech Unleashed identifies several potential types of improvements that agritech can provide, including:

- Optimising inputs through variable rate technologies and practices.
- Timely decision making through real time monitoring systems.
- Increased process automation and labour savings.
- Accelerating genetic gains through objective data.
- Improving market access through improved traceability and product assurance.
- Strengthening biosecurity systems.

The five key barriers to agritech adoption include:

1. Availability of useful data.
2. Data analytics and decision support tools.
3. Connectivity.
4. Trust and legal barriers.
5. The business case or value of investing in agritech.

The business case for investment in agritech is affected by a range of factors including level of capital needed, ongoing operating costs, potential profitability or return on investment. A detailed analysis of what influences farmers to engage in new agricultural practices identified the following as critical factors:

- The relative advantage for farmers of new practices.
- How easily the new practice can be learned.
- The relative benefits of the new practice compared to existing practices.

New Zealand's Agritech Market Opportunity

Agritech exports present a significant opportunity as global demand grows. The New Zealand agritech sector is relatively small by global standards and export revenue from agritech has remained relatively flat for the last five years at approximately $1.2 billion. Most agritech firms are working in the horticulture sector, followed by the dairy sector.

The number of agritech firms and the volume of exports is slowly growing, however New Zealand lacks a 'superstar' billion dollar agritech business. Fundamentally, agritech solutions designed for New Zealand may have limited application in global markets. Not all countries share our natural resources and temperate growing conditions.

Many of New Zealand's agritech vendors focus primarily on the domestic market, without considering exporting. Some haven't sought overseas markets, while others haven't adapted their products for an overseas market. In some cases, it may be difficult to scale the solution for the international market. Collaboration rather than competition, should be sought but this will require companies to focus together on the global market, rather than competing against each other in the domestic market. Strict regulatory settings and complying with data standards globally, may also be a barrier to export.

New Zealand geographic, economic, social and policy benefits provide our agritech industry with a unique competitive advantage on the world stage. They can enable New Zealand to address global megatrends and develop world leading agritech solutions.

Leveraged well, these advantages will facilitate favourable conditions for agritech sector growth;

- our reputational heritage
- free and open markets
- agrifood business models
- geographic advantages
- Governmental and policy advantages
- Social advantages

Unleashing Aotearoa's Agritech

The alignment of policy, investment and skills development will ensure New Zealand is well placed in the future for competitive advantage. The potential increase in exports, will also increase productivity and reduce environmental impact. **Part Three** examines the support ecosystem, strategy and development plans.

Launched by the Government in 2020, the Agritech in New Zealand Industry Transformation Plan (ITP) is a response to the growing recognition of the importance of agritech for New Zealand's continued primary sector growth and prosperity. The ITP acknowledges the importance of a cohesive approach to supporting and developing the agritech ecosystem in order to enable this growth.

The Government's Budget 2020 allocated $11.4 million towards supporting the activation of the ITP over the next two years.

The ITP includes a series of actions broadly grouped into six workstreams, plus three proposed high impact projects. The work streams are designed to support the growth and scaling of our agritech community. It addresses crucial issues including commercialisation, skills and training, investment, global opportunities, data standards and regulation.

Many elements of these work streams will help transition the sector to a post-COVID-19 world. Compared to other countries, the successful implementation and delivery of the Agritech ITP will help scale New Zealand's agritech sector at a challenging time for most. It will also play a highly critical role in supporting our major competitive advantages.

Currently, agritech businesses tend to solve domestic challenges and work competitively. The key to leveraging our competitive advantage is in understanding which global agritech problems are valuable to solve. Growing the agritech sector and the resulting economic benefits will require the entire ecosystem including industry, Government, investment and research working together. With an organised ecosystem, the New Zealand agritech sector is well placed to better coordinate, grow and lift exports.

Recommendations

The Aotearoa Agritech Unleashed study has reinforced how a coordinated, growing agritech sector not only offers significant export growth opportunity, it can also deliver much needed productivity growth.

Even though the ITP was developed pre-COVID-19, it still provides an excellent framework for sector growth through collaboration and investment. This study endorses the recommendations and proposed action plan of the ITP. However, additional opportunities have since emerged and following are four recommendations:

1

Strengthen Commitment to the National Agritech Strategy

Further evolve the ITP from a Government document to a shared industry and Government strategy. Consider publishing, jointly branded, a summary document that speaks to a broader audience to help sell New Zealand's collaboration, ingenuity and leadership across the sector, to the public, and to the world.

2

Develop a Trans-Tasman Agritech Strategy

The potential for a more open trans-Tasman border, brings opportunities to not only access each other's markets, but to collaborate and penetrate global markets. Develop a trans-Tasman agritech strategy to help industry and Government effectively align for shared regional opportunities.

3

Better Understand Local Agritech Adoption

This study has identified the significant economic benefits that could be accrued for the New Zealand economy through increased uptake of agritech by the local primary sector, however little is known about what agritech is used where and the value it is creating. Audit current agritech uptake across the country. Consider designing the audit as a longitudinal study to help track and identify economic benefits.

4

Stimulate Local Agritech Adoption

The evidence is there for farmers to transition to a more sustainable approach but there needs to be a coordinated communication effort to share unbiased, trusted information. Consider mandating technology adoption where it makes sense, for example, for environmental benefits. The Practitioner Working Group within Agritech New Zealand can play a lead role alongside the Government in developing advice and engaging with the farmers and growers.

Key Highlights

New Zealand's primary sector is large and growing.

However, New Zealand's agritech exports are relatively small.

Primary Sector output in 2018

$46.3B

Agritech exports 2013 2018

$1.1 – $1.2B

There are a growing number of agritech companies.

Estimated agritech firms in 2019:

950

$800m

Exported in 2019 by the top 20 agritech exporters.

The Government has allocated

$11.4m

funding to help increase agritech uptake and to help the sector grow.

Better uptake of agritech across New Zealand farms could be worth

$17B

From an estimated

$9.8B

increase in output

and an estimated

$7.3B

increase in exports

CREDIT: Paul Sutherland Photography

_PART ONE

The Agritech Landscape

17

What is Agritech?

The Government's Agritech in New Zealand, Industry Transformation Plan[1] defines agritech as the manufacturing, biotech and digital based technology companies that are creating product, service, intellectual property (IP) and value chain solutions for the agriculture, horticulture, aquaculture, apiculture and fishing sectors, with the aim of improving yield, efficiency, profitability, sustainability, reliability, quality or adding any other kind of value.

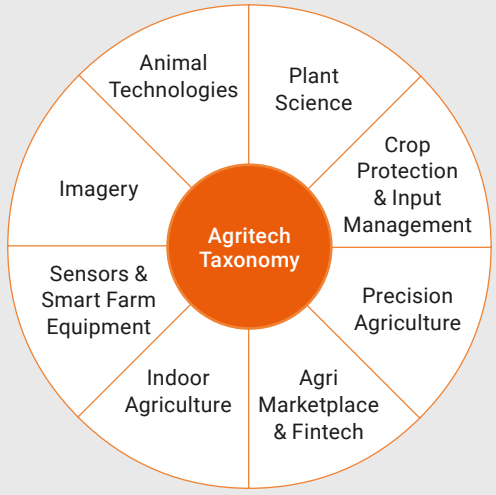
This includes companies who primarily produce agritech solutions, as well as those who develop agritech solutions, but not as their primary business.

Prior to 2012, commercial agritech focused on biotechnologies, particularly investing in plant genetics. According to AgFunder,[2] this began to change in 2013, when global agritech investment grew 75 percent and an estimated 170 percent in 2014. A key driver for the change was the commercial maturity of new digital technologies, for example cloud, mobility and big data analytics. Emerging technologies also show potential for agritech. For example, autonomous vehicles, drones and the Internet of Things (IoT). More recently, augmented reality (AR), artificial intelligence (AI), and blockchain are appearing in agritech solutions.

Currently, there is no agreed, global definition of the sub-sectors of agritech. For the purposes of this report, we are referencing pitchbook.com's agritech taxonomy.[3] This includes farming inputs, production and harvest. It also includes some midstream applications such as food safety and traceability technology. For a more detailed breakdown of this taxonomy please refer to the appendix.

Agritech includes manufacturing, biotech and digital based technology companies that are creating novel product, service and value chain solutions for the primary sector.

FIGURE 1: Agritech Market Segments



Source: Designed from Finistere Ventures & PitchBook ,2017.

New Zealand's Agritech Landscape

A History of Innovation

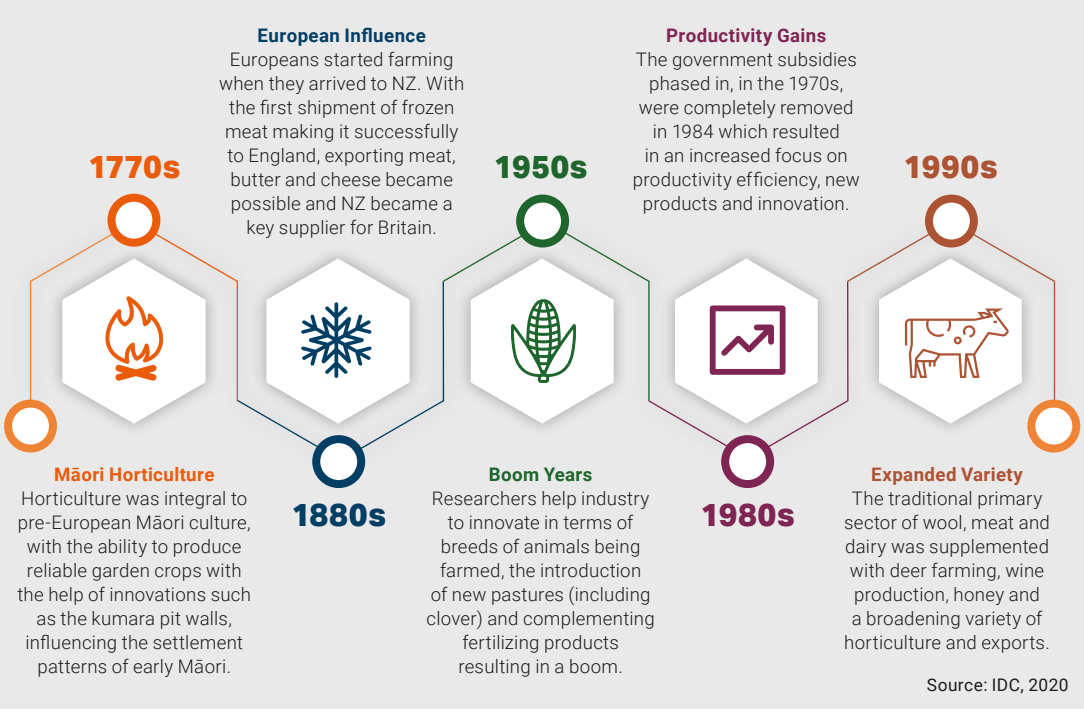
Agriculture has historically been the mainstay of the New Zealand economy and will continue to play a critical role in the future.

The New Zealand economy has been built on agriculture and for more than 100 years, its primary sector has been a world leading exporter of quality food. In the post-COVID-19 era, agriculture is likely to continue to play a critical role due to the dramatic impact on other export sectors, like tourism.

Throughout time, New Zealanders have innovated on the farm, in the orchard and across the primary sector bringing world first innovations to life to help produce better food. From mechanical innovations such as the electric fence, to biotech innovations like gold kiwifruit or digital innovations like AI enabled smart cow collars.

New Zealand has a proud, rich agricultural history which has been the mainstay of the economy. New Zealand's food and fibre sector, including processing and commercialisation activities, contributes 11 percent to the gross domestic product (GDP).[4] Agriculture is crucial to the economic and social fabric of rural communities, the regions and New Zealand. It is also among the country's largest employers through both direct employment and via adjunct services and related industries.

FIGURE 2: Milestones in New Zealand Agri Innovation



Source: IDC, 2020

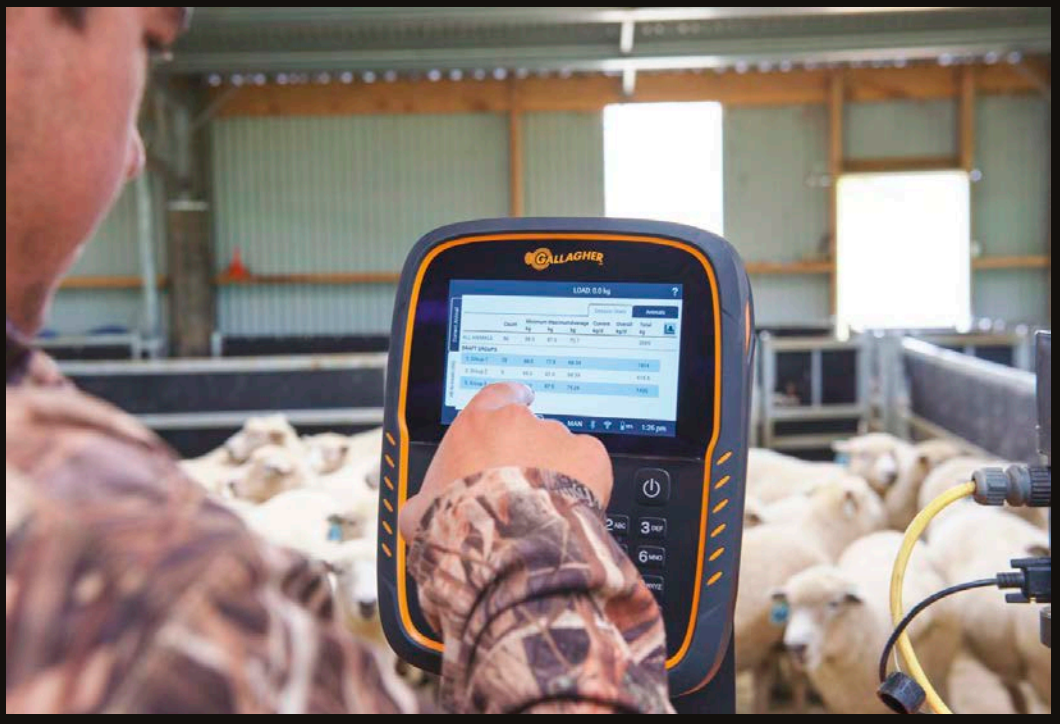
GALLAGHER – A Story of Agritech Innovation

The Gallagher innovation story demonstrates the typical New Zealand approach to agritech.

In the early 1930 s when a horse called Joe took too much of a liking to using a car as a scratching post, owner Bill Gallagher Senior scratched his head for a solution. He devised an electrical circuit that delivered a shock whenever the horse rocked the vehicle. This quickly solved the problem and sparked the idea for his electric fence invention.

More than 85 years later Gallagher is a global technology leader in Animal Management, Security and Fuel Systems. Gallagher continues to innovate in the Animal Management sector which includes solutions in electric fencing, weighing and electronic identification, and water monitoring systems.

With a focus on design and digital excellence Gallagher is leading the world in their industry, providing solutions that integrate on farm devices with IOT technology. This combination provides easily accessible performance data to enable their customers to make better informed business decisions.



The hallmark of New Zealand agriculture is innovation through the years. Before Europeans arrived, Māori ate seafood, birds and cultivated crops. Māori cultivated fields until yields declined, abandoning them for new plantations won from the forest, or second-growth bush and fern land. Māori horticulture focused on kumara, taro, hue and yam. Kumara provided the most significant volume and spread. A reliance on kumara saw the advent of kumara storage pits which were used to preserve the crop, avoid decay and protect against theft.

As European settlers arrived in New Zealand, they observed the key tenets of Māori horticulture; cooperative labour and the importance of soil health. European farmers expanded on existing models of Māori agriculture, introducing a wide range of food plants, including wheat, maize, potatoes, cabbage and carrots. They also introduced a larger variety of kumara than previously grown.

Early exports focused on non-perishable sheep products and native timber. However, New Zealand's primary industry evolved with the advent of refrigerated shipping in the 1880s. In February 1882, New Zealand's first cargo of frozen meat departed Port Otago, bound for London. When the cargo arrived 98 days later and in excellent condition, it heralded the beginning of New Zealand's excellence in the handling of refrigerated cargo.

Subsequently, New Zealand was well positioned to benefit from the European food shortages of the 1950s following World War II. Britain was a key partner of New Zealand exports, largely due to animal breeding innovations, the introduction of new pastures and advancements in fertilising technology across New Zealand's range of climates.

The removal of Government subsidies in 1984 has long been touted as the driver for innovation in the agriculture sector. Agriculture was the primary target of Government moves to deregulate the New Zealand economy. Within a 12 month period, the Government removed all production subsidies, as well as funding for drought relief, floods and other natural disasters. The outcome was an increase in agricultural research to maintain farm income that had been lost in the removal of subsidies.

Since the removal of subsidies New Zealand agriculture has diversified. The traditional primary sector of wool, meat and dairy was supplemented in the 1980s and 1990s with deer farming, wine production, honey and a broadening variety of horticulture. Farm numbers have decreased while land area per farm has increased (suggesting a consolidation of farming) and agricultural exports have shifted in favour of more processed, higher value products.

From approximately 180,000 hectares of land, in 2019, New Zealand exported $18.1 billion of dairy, $10.2 billion of meat and wool, $6.8 billion of forestry, $6.1 billion of horticulture, $1.9 billion of seafood and a further $3.1 billion of other food such as honey and processed food.[5]

ZESPRI, the Kiwifruit and Artificial Intelligence

In 1997 a group of New Zealand kiwifruit growers formed Zespri International as a cooperative.

Through Zespri the industry collaborates to invest in research and development.

In 2017 Zespri embarked on a program of research using machine vision and artificial intelligence (AI) to digitise the kiwifruit industries crop estimate process.

The annual crop estimate is used by growers and packhouses for supply chain optimization, and by Zespri to make key marketing decisions. An accurate crop estimation has substantial cost consequences for the industry which directly impacts on the grower return.

The Digital Crop Estimation program is currently focused on improving the accuracy and precision of the crop estimate count and size components. Over 1600 ha of kiwifruit were scanned this season alone, and the results prove that this technology is extremely effective and reliable at determining fruit density. The emphasis of future research will be on improving the other components that make up the crop estimate, and using the data collected to improve other aspects of the supply chain and on orchard management.

The New Zealand Agritech Sector

New Zealand has a broad based agritech sector with technology and biotechnology supporting all aspects of the country's agricultural sector.

A recent analysis of the combined databases of industry group Agritech New Zealand, New Zealand Trade and Enterprise (NZTE) and Callaghan Innovation identified over 950 likely agritech companies.[6] While this is only a subset of the full agritech sector, it is assumed that this data captures the most significant firms within the sector.

Research by the Technology Innovation Network (TIN)[7] into the top 200 technology export companies in New Zealand has identified that the top 20 agritech firms generated $1.4 billion in revenues in 2019. These firms are predominantly high-tech manufacturers, however three of the top 10 are also biotechnology firms. They invested $97.3 million in research and development (R&D) or 6.9% of their revenues as they fine tuned their products to markets. The TIN research also found that agritech firms experienced increased profitability in 2019 with earnings before interest, tax, depreciation and amortization (EBITA) growth of 10.2 percent.

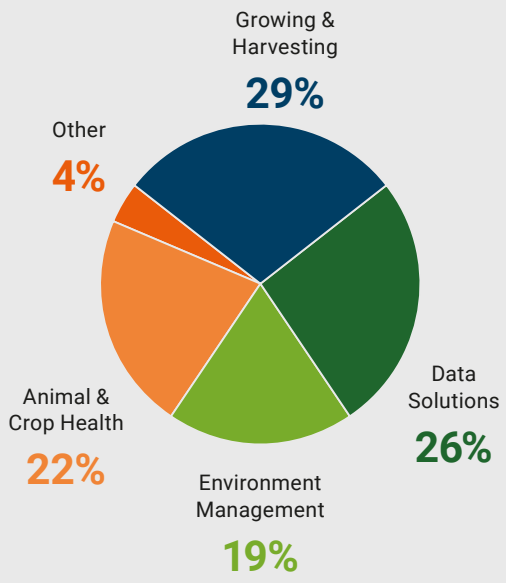
While the agritech sector is spread throughout New Zealand there are clusters within regions such as farming in the Waikato, Palmerston North and Canterbury, horticulture in the Bay of Plenty and viticulture in the Marlborough and Hawkes Bay regions.

In addition, there is also a range of different agritech businesses operating in New Zealand. An analysis of the Callaghan Innovation agritech customers[8] identifies just under 30 percent of firms are involved in growing and harvesting technologies, for example on farm automation, robotics and aquaculture. Data solutions, for example, sensing and analytical testing contributes 26 percent, about 18.5 percent in environment management, 21.5 percent in animal and crop health and a small number operating in indoor growing. Of these agritech companies, 42 percent are considered early stage, 20 percent growth stage and 38 percent mature.

950+

Agritech firms in New Zealand

FIGURE 3: New Zealand Agritech Activity



Source: Callaghan Innovation, 2020

New Zealand Agritech Exports

New Zealand is punching below its weight in agritech exports.

According to Government research, the agritech sector has continued to contribute a stable $1.1 billion to $1.2 billion in export revenues over the past five years to 2018.[9] This only includes goods, not services, due to the lack of data specific to the agritech sector.

Additional research from TIN[10] on the exports of the 20 largest agritech exporters found that they contributed $803 million in exports in 2019. This was a 2.9 percent growth on the previous year.

However, it has led to the conclusion that New Zealand is underperforming, relative to its global peers. New Zealand food and fibre exports have grown substantially over this period and worldwide investment in agritech has increased by 36 percent per year. Consequently, both the small scale of agritech exports and the lack of growth are either a cause for concern, or a significant opportunity.

A Government Agritech Strategy

In July 2019, the New Zealand Government refreshed its approach to industry policy. The core of this new approach was the development of Industry Transformation Plans (ITPs) for select sectors of the economy, where significant growth opportunities exist. The first sector identified, with the biggest potential was agritech.

Agritech was selected as a priority sector because of its importance to New Zealand's transition to a highly productive, low-emissions future, its adjacency to a strong food and fibre sector, and existing expertise and investment in this area. The 2018 establishment of industry group Agritech New Zealand and

Annual New Zealand agritech exports (approximately)

$1.2b

GPS-it Mapping Farms and Orchards

In 1998, Matt Flowerday began professionally using GPS to map farms and orchards. He launched GPS it in 2001, initially to help kiwifruit growers map their orchards. Accurate farm mapping is essential for planning, recording, decision support and compliance (including health and safety). Over time, the organisation has developed and is now the leading aerial farm mapping and software development company in New Zealand, with customers throughout the world.

GPS it measures and collects geospatial data and presents it in an accurate and easy to use format that assists farmers daily farm management. For example, feed budgeting, recording and tracking fertiliser applications, planning paddock rotation, allocating stock rates and recording movement. GPS it maps are also useful for staff and contractors to understand the farm layout when carrying out tasks. GPS it provides 85 percent of mapping services in New Zealand's horticulture industry. The company s customers include some of the largest agri businesses in the country such as Fonterra and Zespri.

their role as a cooperative partner with the Government was also an influential factor.

The intention behind the Government's focus on agritech, is to grow the sector as an economic driver in its own right, with particular emphasis on high value export opportunities and further diversifying the New Zealand economy.

The Government's ambition is to grow the agritech sector so it is better equipped to service both the domestic and international markets.

> ***New Zealand possesses a number of comparative advantages when it comes to agritech. If we can effectively exploit this advantage, we stand in a good position to increase our share of the global market.***
>
> Agritech Industry
> Transformation Plan, 2020

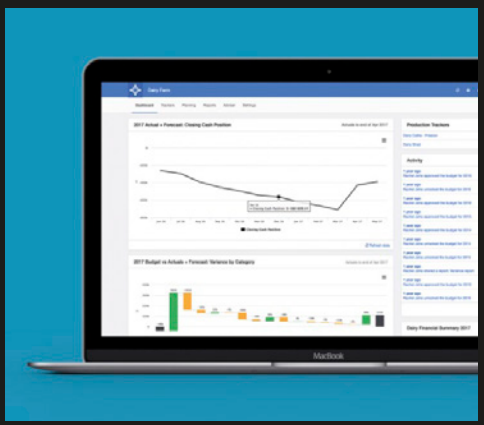
This Government strategy, the Agritech Industry Transformation Plan (ITP)[11] was developed in collaboration with an all-of-government agritech taskforce, encompassing seven Government agencies, and the recently formed industry group, Agritech New Zealand.

The ITP was launched in 2020, including an action plan and initiatives to grow the ecosystem, plus connecting it to global capital and markets.

FIGURED Specialised Farm Accounting Software

Auckland based software company Figured was launched in 2014, created out of a desire to farm smarter.

It was founded by Carl McDonald and David Marshall, both farmers and accountants. They were frustrated by the lack of financial management tools available specifically for the farming sector and its unique requirements. Together, they created the specialist financial management solution that works with Xero accounting software. Figured is a complete livestock, dairy and crop budgeting, production tracking and forecasting tool providing accurate data in one place, in real time. Figured s solution allows both farmers and their trusted partners and advisors to easily access and view a farm's financial information. Figured operates in New Zealand, Australia, the United Kingdom and the United States of America. More than 20,000 farms are currently using its solution.



The Global Agritech Landscape

Global Agritech Market Growth

Globally, the adoption of technology in an agricultural setting continues to grow.

Agritech has become an industry in its own right. It is now worth around $250 billion worldwide every year and is forecast to grow at a CAGR of over 18 percent through to 2025.[12] According to specialist agritech investment firm, Finistere, agritech is now a rapidly maturing sector as more expertise and resources are drawn to the category. This growth is driven by global megatrends including:

- An increasing world population urging farmers to be more productive.
- Changes in consumer demand, such as increasing demand for high nutrition foods and alternative proteins. These are a threat to traditional animal protein based farming.
- Increasing pressure from regulatory bodies and society to farm more sustainably.
- New generations of consumers who increasingly use data in their decision making. They are more socially conscious about provenance and sustainability of products than previous generations.

These megatrends have resulted in increasing agritech activity as farmers strive to produce more food, at a higher quality and in a more sustainable way. Traditional agritech fields such as biotechnology can also benefit from digital transformation. Agritech companies are either digitalising manual processes, using technology to create new solutions or completely disrupting an area of agribusiness.

Currently, there isn't a standard global measure for agritech exports, so the best proxy for comparisons is agritech investments. According to AgFunder, US$7.6 billion dollars was invested globally in agritech firms,[13] across 1039 deals representing a 1.3 percent increase year on year. The United States of America accounted for 43 percent of global agritech investment with China next closest at 16 percent. While comparative countries like Israel and Canada attracted around three percent each of global investment, Australia and New Zealand were both under half a percent. This strongly suggests both markets are underperforming.

Worldwide agritech worth

$250b

a year

Global Leaders in Agritech

Government support drives successful agritech exporting countries

Worldwide agrifood production is approximately US$3 trillion value at the farm gate. This expands to US$7.8 trillion across the entire agrifood sector. As agrifood production grows so does agritech.

There are several countries that are prominent leaders in agritech; Israel, the Netherlands and the United States of America. For some countries, leadership comes from necessity. In others, it is due to national policy and strong agritech investment.

Agritech is also lifting the productivity of nations that were once traditional farming nations. For example, agritech has become a major export sector for Israel, Ireland and the Netherlands.

Singapore, Israel and the Netherlands have also proven themselves to be leaders in both innovation and adoption of agritech. In each country, resource constraints have driven innovation. The governments of each country have supported, encouraged or incentivised agritech market growth and agritech adoption.

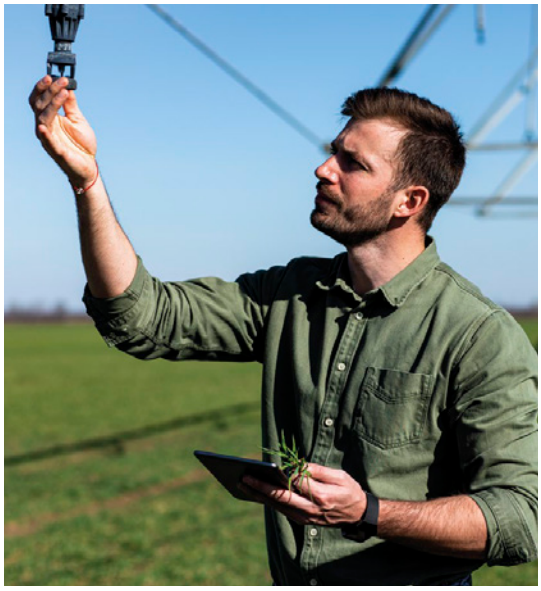
Other countries showing promise in agritech are the United Kingdom and Ireland. Both have similar pastoral systems to New Zealand, particularly Ireland. Again their agritech success can be attributed to government focus on solving the increasing problem of feeding the populations.

Israel

Israel's agritech industry faces significant political, historical and environmental challenges. However, according to a 2018 report, it is a global leader in agritech.[14]

Israel is one thirteenth the geographic size of New Zealand but the country has nearly twice the population, at almost nine million people. With the Negev desert covering more than half the land area, only 20 percent of Israel's land is arable.

Israel has triumphed against adversity with a long list of agricultural innovations to its name. In the 1960's, the Israelis invented drip irrigation which minimises evaporation and increases crop yields by watering only the roots of a plant. The country recycles 86 percent of its waste water with sewage cleaned until it is safe to drink. The country has also been at the forefront of recent agritech innovation. For example, it has developed drones to monitor fields for pests or weeds and fruit picking robots. Israel is also credited with inventing GrainPro cocoons that protect grains and pulses from pests and mold to reduce wasted produce. Israeli company Biofeed also creates



environmentally friendly lures that capture fruit flies to reduce them spoiling mango production.

More than 300 multinationals have Israeli based operations. Israel is also a R&D hub with a strong agritech research focus. Investment in Israeli agritech has also led to rapid growth in the number of agritech companies. According to Israel's Start-Up Nation website there are over 460 active agritech companies in the market.[15]

The Netherlands

The Netherlands has a population of 17 million people and has a relatively small geographic area of 41,543 square kilometres, about 6 times smaller than New Zealand. However, aside from the United States of America, the Netherlands produces the most food exports globally, approximately 92 billion euros in the 2016/17 year.[16]

The Netherlands had a prosperous economy in the 1970s, however as time progressed,

fewer young people wanted to work in farming. Dutch farms are relatively small, approximately 25 hectares each,[17] so it is challenging for farmers to make large, scaled investments.

It may have made sense for the Netherlands to bypass its agricultural sector and focus on other parts of the economy, for example banking and technology. However, the economy was not the only driver. Following serious food shortages during World War II the Netherlands did not want to be reliant on food imports. Policy encouraged farmers to use technology to maximise food production. Between 1960 and 2007, the average milk production per cow increased from 4200 kg per year to 7880 kg per year.

The Netherlands has specific policies for commercialising research to ensure innovation reaches industry. To help farmers with technology, the Government has also implemented the Agricultural Council Offices to link the agritech and farming sectors. The Offices help farmers understand what type of technology would best suit the problems they would like to solve.

The Dutch aren't just using their technology innovations in the Netherlands, they are successfully exporting tech with 9.4 percent of Dutch agri food exports as technology and materials. This is the single largest element of their food section exports. This includes most of the world's poultry farming machinery and a large amount of cheese production machinery.

Singapore

Singapore faces considerable resource constraints due to its small land mass and large population. Only eight percent of vegetables consumed by Singaporeans are produced on local farms. The population is highly dependent on imported food, making Singapore vulnerable to volatilities in the global food market. However, Singapore is a hub of technical innovation making it ripe for innovation in non-traditional farming methods, for example, indoor growing technologies.

Singapore's Government supports the desire for local food products. The Government has developed a programme to support both local farmers and agritech companies. Launched in 2019, it is called the '30 by 30' programme. Its ambitious aim is to produce 30 percent of its own food by 2030. The programme supports agritech development and vertical urban farming. It is also supported by new agriculture tertiary education courses to train the 'farmers of the future'.

Enterprise Singapore has an Agritech investment arm, SEEDS Capital. It also runs the annual competition, Indoor Ag-Ignite, where finalists pitch their agritech ideas to a judging panel vying for a startup grant. The winners also receive technical advice and consultancy. The competition encourages international entrants and companies don't need to be incorporated in Singapore to enter the competition. However, they must be incorporated to accept a grant. Effectively, Singapore encourages companies to come to Singapore.

Venture capitalist firm AgFunder also runs the agritech GROW startup accelerator in Singapore. It is supported by Enterprise Singapore and the Economic Development Bank. The accelerator is based in Singapore, but accepts applications from organisations in any country.

United Kingdom

The United Kingdom's (UK) agricultural industry has a long history of innovation. Britain is widely acknowledged as developing innovative crop rotations during the British Agricultural revolution between the mid-17th and late 19th centuries. The British also developed new wheat cultivation methods in the 1960s and 1970s that almost doubled wheat yields.

Britain's land area is about 240,000 square kilometres, a similar size to New Zealand. The British use around 70 percent of their land for agriculture, with around one-third of that being arable land. The rest includes grasslands, grazing and woodlands. In comparison, New Zealand only uses approximately 42 percent of its land for agriculture.

The significant difference between the UK and New Zealand is the population. In 2018,

BIOLUMIC Delivers UV Technology Lifting Crop Performance

Increasing yields sustainably is what drives the team at BioLumic, who combine photobiology, engineering and data science to maximise the power of ultraviolet (UV) light.

Headquartered in Palmerston North, Biolumic is a research and development centre. It is currently developing UV technology to improve plant growth and yield. The company's research has found that exposing seedlings to UV light can trigger biological mechanisms to improve crop performance.

Biolumic currently has field trials in progress in Europe, North America and Mexico. Previous trials with more than 15 million seedlings have shown BioLumic UV can increase crop yields by more than 10 percent. In 2019, Canadian medicinal cannabis firm Canopy Rivers invested US$1.5 million bringing its research funding to US$6.7 million.

the UKs population was 66.4 million people, and is expected to grow to 69.4 million by 2028 and 72.4 million by 2043. However, the UK is not self-sufficient when it comes to food, importing 48 percent of the total food it consumes. The UK Global Food Security programme says it expects that proportion to rise and is looking to bolster its agriculture sector by increasing investment into agritech.

In 2018, the UK announced plans to invest £90 million to improve agritech. Its longer term goal is to create better, higher paying jobs in the sector. It also aims to increase productivity to address increasing food demands. The UK Department of International Trade regards New Zealand as being a strong potential global partner for this sector.

Ireland

Ireland has a mild and moist climate, with a relatively high annual rainfall, providing excellent farming conditions. Approximately 65 percent of Ireland's land is used for agriculture. Ireland shares similar pastoral farming systems with New Zealand and farming is an important part of Ireland's economy. There are approximately 137,500 farms employing 8 percent of the working population. The country exports €12 billion worth of agricultural products per year.[18]

The European Common Agricultural Policy (CAP) supports agriculture in Ireland via a 'basic payment' subsidy to farmers. It also offers incentives for on-farm innovation and has a rural development fund. This prioritises restoring, preserving and enhancing agriculture ecosystems. The EU's Horizon 2020 programme supports Irish agriculture via research and innovation. The programme places researchers together with industry to solve agricultural problems. This is known as the 'multi-actor approach' and appears to be common among countries with a strong agritech sector.

In 2015, Ireland abolished the 31 year old European Union milk quotas. At the time, the Irish agricultural minister said it was the most important policy change for rural Ireland in 30 years. Since milk quotas were removed by the European Union five years ago, milk production has increased by 50 percent in Ireland. In 2017, the highest value increase across agricultural commodities was for milk, an increase of 45 percent that year from €1.8 billion to €2.6 billion.

The removal of milk quotas offers New Zealand agritech companies an interesting market opportunity. The removal of quotas is leading to larger farms and herds and drives opportunity for New Zealand dairy tech companies.

The Impact of COVID-19

The Impact on the New Zealand Agritech Sector

A resilient sector, concerned about customers

During the early part of 2020, as the COVID-19 pandemic disrupted the world economy, the New Zealand food and fibre sector continued as essential services. The impact of the COVID-19 lockdown on the agritech sector was largely unknown, so Agritech New Zealand surveyed the sector to gain a better understanding of the sector's resilience. For survey methodology, please refer to the appendix.

Biggest Challenges

More than 50 percent of respondents identified that access to customers was their biggest business risk, specifically decreased sales and cancelled projects. This was particularly explicit for small and medium sized enterprises (SMEs), with 100 percent of small business respondents identifying the impact on their customers as their main concern.

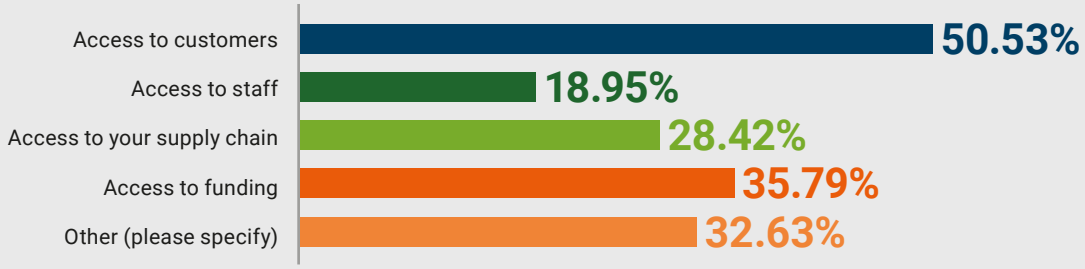
Another key concern was the impact on funding. This was felt most by smaller organisations, with all startup respondents identifying funding as a major risk. However, at the time of the survey 40 percent of respondents had taken advantage of the Government's economic recovery packages.

The impact and reliance on external suppliers, plus travel restrictions were also having a significant impact on agritech companies. The impact on exports and the inability to enter markets to physically meet customers was inhibiting growth with more than 50 percent identifying international travel restrictions negatively impacting their business.

Government Support

The survey also identified how agritech companies were accessing support from the Government and areas where further support may be required. The most common theme was financial support, with 50 percent of respondents indicating this need. Most were seeking business funding support, however reduced taxes and an extension of the wage subsidy were also highlighted. Organisations involved in R&D and innovation were most concerned with potential setbacks. They suggested the Government increases its focus on stimulating and supporting R&D. For early stage companies

FIGURE 4: Biggest Risks for Agritech Companies as a Result of COVID 19 Lockdowns



Source: Agritech New Zealand COVID-19 Insights Survey, 2020 n=121

TRACMAP Providing GPS Guidance

New Zealand company Tracmap provides farmers with its GPS guidance and job management system. A GPS display unit sits within each farming vehicle, connected to a cloud based job management system. Farm managers send jobs via the app to the field team. These jobs could include a block of crops to harvest, or fields to fertilise. This increases precision and quality of jobs completed. It also increases efficient utilisation of resources, such as people and machinery.

Since installing their first GPS guidance systems in 2006, Tracmap has become New Zealand s largest agricultural GPS provider. This includes aviation, bike, truck, tractor, effluent management and live fleet tracking. Now, over 70 percent of all fertiliser applied to New Zealand farms is completed using TracMap guidance.

raising capital, the concerns focused on the difficulty in finding investment, without the loss of intellectual property. Suggestions included bridging finance or other financial support.

The Agritech New Zealand COVID-19 survey provided timely new input into the Government's Agritech Industry Transformation Plan. While COVID-19 continues to have a major impact on the global economy, a strong demand for New Zealand food remains. Prior to the pandemic, global investment in agritech was growing and New Zealand now has a unique opportunity to take a larger slice of the global market.

Long Lasting Challenges

A paper published by KPMG[19] during the COVID-19 lockdown in April 2020 noted that once the immediate health challenges pass the economic challenges will persist for some time. New Zealand will need to rethink how international trade is conducted, explore opportunities to collaborate, review product innovation strategies, assess risk analysis approaches and put digital first.

Understanding changes in consumer behaviour will be critical to the success of the recovery of the New Zealand agri-economy and agritech will play a vital role. The KPMG report stresses that the era defining issues present at the start of 2020 remain even more important. Consumer concerns about climate change, food safety, healthy living environmentally sustainable produce will persist.

The Opportunities Emerging

Agritech customers provide an essential function – growing food

AgFunder recently reported that the COVID-19 pandemic is seriously impacting supply chains and some investors are dramatically reducing their activity. Subsequently, some valuations have dropped as much as 40 percent.[20] An April 2020 survey[21] of agritech customers by New Zealand's R&D agency, Callaghan Innovation, found that while 46 percent were experiencing negative impacts such as described by AgFunder, for 25 percent it was business as usual and the remaining 29 percent had identified new opportunities.

Business growth predictions remain uncertain as end-users delay investment in new technology while anticipating the expected economic recession. However, food production remains an essential function and demand for food output looks likely to continue. For the agritech startups that can survive the initial market turmoil and pivot for areas of new demand, the future looks bright. It is expected new demand will accelerate, particularly in:

Helping to Address Labour Shortages

As borders close, farmers who typically rely on seasonal migrant workers coming into the USA to work for them, have to contend with an even greater labour shortage than before. As a result, the industry is paying additional attention to robotics and automation. This labour shortage is not limited to the USA with many New Zealand growers also facing labour challenges due to COVID-19 travel restrictions.[22]

> ***"To this day I have never met a grower who has said that water is their number one issue. The biggest issues are labour shortages and the rising costs of labour."***
>
> **George Kellerman,**
> Yamaha Motor Ventures

Supply Chain Challenges

Food waste is another challenge that has become increasingly apparent, so supply chain optimisation tech is in growing demand.

ROBOTICS PLUS Leading Agricultural Automation

Robotics Plus is a New Zealand agricultural robotics and automation company that emerged from the need to solve the increasing challenges of labour shortages, sustainability for apple growers and yield security. Their flagship innovation is a robotic apple packer. Packing apples is a labour intensive task for packhouses around the world. The labour to fulfil this role is often difficult to find, which can jeopardise the produce if it is not packed in time.

In 2018, Robotics Plus signed an agency and distribution agreement with Global Pac Technologies, which allows its robotic apple packers to go global. This has fueled a period of accelerated growth for Robotics Plus ,as industry demand for its innovation grows. Other projects include a kiwifruit picker, unmanned ground vehicle (UGV), automatic log scaler and a quad duster.

Between 2018 and 2020 Robotics Plus has raised US$20 million in funding from Yamaha Motor Company.

Globally, while farmers are re-evaluating the role that technology may play in helping them rapidly adapt to the new market, it may be some time before the innovation pipeline, that brings new ideas and tools, gains momentum. This is expected to create a demand and supply imbalance favouring agritech firms who can respond rapidly to new opportunities.

_PART TWO

The Economic Opportunity

35

The New Zealand Agritech Opportunity

High value export opportunities are not the only potential economic benefit of a vibrant New Zealand agritech sector. Local productivity gains through better use of technology in the primary sector will provide the most significant economic opportunity.

Productivity on the farm in New Zealand has remained relatively flat over time, however small improvements can generate significant returns.

The value of New Zealand's primary sector output, including agriculture, horticulture, forestry and fishing was almost $46.3 billion in the year to the end of March 2018.[23] Economic consultancy Sapere, have estimated that if a range of agritech solutions were fully applied in our primary sector, this level of output and our productivity, could be increased significantly.

Productivity is a key measure of performance and profitability on farms, forests and in the ocean. Its level reflects the efficiency of primary sector inputs; land, labour and capital to produce outputs.

It is challenging to estimate potential output and productivity gains, because in many cases agritech systems and technologies are in experimental stages. However, Sapere analysed the New Zealand market based on similar international studies, to estimate the potential economic benefits of improved use of agritech on New Zealand farms.

Using a range of approximations of the value of agritech, it is possible to estimate that New Zealand's output could be around 21 percent or $9.8 billion dollars higher.[24]

This analysis is based on the approach of the Australian Farm Institute, which gathered estimates of productivity gains possible from a range of agritech solutions designed to achieve 'decision agriculture'. The Australian study[25] defines decision agriculture as the analysis of digital farm data, along with other datasets such as soil and environmental data, which leads to improved decision making by farmers and enables the use of data-driven technology. Decision agriculture is enabled by tools and technologies including precision agriculture, IoT, digital monitoring systems, cloud computing and other digital technologies.

Better uptake of agritech in New Zealand could improve farm output by up to

$9.8b

Where possible, the estimates were measured against New Zealand studies. For example, studies showing large potential productivity gains in the dairy sector.[26]

The estimate of $9.8 billion dollars greater output represents the value that could be achieved in the best case scenario of fully implementing these agritech solutions. While this is not achievable over a short time period, it suggests that even if half these agritech solutions were applied, by half of those in New Zealand's primary sector, there would be considerable benefit.

Potential Increase in New Zealand Primary Sector Exports from Fully Utilising Agritech

As well as improvements in direct farm output, there could be additional benefits for the New Zealand economy through increased primary sector exports. The value of New Zealand's primary sector exports, covering agriculture, horticulture, forestry and fishing was $46.4billion in the year to the end of June 2019.[27]

If a range of agritech solutions were fully applied in our primary sector this level of exports could be increased significantly. Based on a range of available approximations of the value of agritech, it is possible to estimate that New Zealand's primary sector exports could be around 20 per cent or $7.3 billion dollars higher.

The estimate of $7.3 billion dollars greater exports represents the value that could be achieved in the best-case scenario of fully implementing a wide range of agritech solutions in the primary sector.

Subsequently, the question is how to astutely apply the most promising technologies to help our primary sector increase its productivity and exports for competitive advantage on the global market.

Better uptake of agritech in New Zealand could improve primary sector exports by up to

$7.3b

"I've been in the kiwifruit industry for 34 years now and we're still picking into a bag that I picked into 34 years ago. There's been a real disconnect between agriculture and technology for a long time and now the pressure is coming."

Steve Saunders,
Robotics Plus

Sources of Agritech Value

Sapere's analysis, based on the Australian study,[28] estimated the increase in value from fully employing decision agriculture. The study modelled the application of a range of agritech systems and technologies to Australia's primary sector. It focused on activities where key decision making was made at the farm level. For additional information and sector commentary please refer to the appendix.

The study identified several potential types of improvements that agritech systems and technologies could provide, including:

- Optimising inputs through ***variable rate technologies*** and practices.
- Timely decision making through ***real time monitoring systems***.
- Increased ***process automation*** and labour savings.
- Accelerating genetic gains through ***objective data***.
- Improving market access through ***improved traceability and product assurance***.
- Strengthening ***biosecurity systems***.

RAVENSDOWN Develops Effluent Treatment System

Ravensdown is a key supplier to agribusinesses in New Zealand.

The company's core product is fertiliser for pasture growth, but it also supplies agrochemicals for pest and weed control. Ravensdown was established during the 1970s gumboot revolution in response to a pending superphosphate monopoly. In 1987, Ravensdown became a 100 percent farmer owned cooperative. After celebrating its 40th anniversary, Ravensdown redefined its purpose in 2018; to enable smarter farming for a better New Zealand. Ravensdown aims to reduce environmental impacts and optimise value from the land. Ravensdown is also known for its award winning effluent treatment system. The system separates effluent particles from water particles, removing bacteria. Farmers can then re use the water for wash down or irrigation. Ravensdown estimates that farmers could save 42 billion litres of freshwater usage by recycling water.

Optimising Input Use Through Variable Rate Technologies and Practices

Variable rate technologies (VRT) allow farmers to accurately vary the application of a product, based on precise location, time or the qualities of an area. It uses spatial and temporal data. A key example is changing the application of fertiliser, seeds and water to suit the needs of different soil types within a paddock.[29] These technologies are used with cropping[30] but could expand further into livestock farming for individual animal management and pasture management. They could also help increase the productivity of horticulture and viticulture through optimising crop nutrition and irrigation.[31]

Timely Decision Making Through Real Time Monitoring Systems

Agritech systems can also offer real time, or close to real time, monitoring to improve decision making. These can include sensors which can monitor production including crop or livestock health. Timely decision making can help increase productivity through the efficient use of inputs and greater outputs.

Increased Process Automation and Labour Savings

In the primary sector, labour is a major cost of production and improving labour efficiency offers significant gains. Technology is likely to be of most value where standard, routine and predictable work needs to be accurately and quickly completed. Processes that can be automated by sensors, for example, assessing kiwifruit or meat cuts, can increase productivity. This is achieved by reducing labour costs, increasing handling accuracy and lowering wastage. There are also likely to be improvements in workplace health and safety from use of these technologies.

In addition, using digital technologies can further result in productivity improvements by simplifying market and regulatory compliance requirements. This reduces the duplication of information requirements and slower, more costly, manual paper based systems.

Accelerating Genetic Gains Through Objective Data

In recent decades, there have been significant advances in plant and animal genetics through genetic benchmarking and genomics. Significant agritech gains are forecast from these

ABACUSBIO Improving Agricultural Performance

AbacusBio s scientists undertake research for agribusinesses around the world.

The consulting firm has offices in Dunedin and Rotorua, New Zealand and Edinburgh in the United Kingdom. Bridging business and science, it focuses on improving agricultural performance and sustainability. It also helps agribusinesses to adapt to changing consumer behaviors and trends. In response to challenges, the team collaborates on creating, developing and implementing solutions. In a current project, AbacusBio is developing a technology platform to support small ruminant breeding programmes in Africa. In another project, they are working on genomic selection to improve honeybee performance. In both instances, AbacusBio is translating science and technology expertise into commercial outcomes. The people centric firm is known for its practical, down to earth approach.

technologies. Data analytics is an important component as it can link genetic, production and processing information and provide insights not otherwise available. This can provide significant productivity gains in the livestock sectors with genotype, phenotype and meat processing, better linked to market demand.

Improving Market Access Through Improved Traceability and Product Assurance

Avoiding pests and diseases is critical for New Zealand's primary sector. Biosecurity is essential to continue exporting to our key trading partners. Automating biosecurity platforms and potentially integrating them with traceability and provenance systems, could further increase effectiveness. Improved traceability can also forestall catastrophic losses from serious biosecurity threats. For example, anticipating the risk and minimising the impact of Queensland fruit flies or foot and mouth disease.

Agritech Adoption Barriers

Various researchers have investigated the constraints on the adoption of agritech. A recent report on the adoption of agritech solutions in New Zealand[32] highlights that practice change needs to be considered not just the acquisition of new tools. The report also notes that adoption rates can be affected by diversity of farm scale, regulations, connectivity and farmer appreciation of value. Our review of several studies identified five key barriers to uptake:

- Availability of useful data.
- Data analytics and decision support tools.
- Connectivity.
- Trust and legal barriers.
- The business case or value of investing in agritech.

These barriers are dependent on each other and interrelated to varying degrees.

Availability of Useful Data

In recent years, computer capabilities have increased exponentially and data storage costs have fallen. It is now possible to collect increasing amounts of data from the primary sector and its value chains. However, handling data volumes, different formats and data quality can create its own challenges. Another issue can be interoperability and data sharing.

The availability of relevant data is needed for many agritech ventures to succeed. For example, to effectively use VRT for cropping,

ZEDDY Smart Meal Feeders

A focus on smart farming has seen Palmerston North based Zeddy develop smart meal feeders for farming animals. The system helps ensure each animal is getting the nutrition it needs.

The Zeddy Dry Feeder can identify every single animal by its RFID ear tag and dispense a predetermined amount of feed. The towable feeder unit records feeding data. In built controls, farm specific customisation and real time alerts allows for key farming concerns to be addressed. This includes minimising wastage traditionally caused by weather damage and set ratios means there is no over feeding. Zero waste also means lower feed bills for farmers. A complete feed history can be viewed online. Farmers can monitor and control individual nutrition to ensure optimal diet and long term farming productivity.

detailed data is needed on the area's soil types and yield history. The Australian Farm Institute report noted that while many agritech applications do not use multiple data sources, the most productive ones do.[33] For example, in the beef sector where 85 percent of the estimated total gains were likely to come from linking genomics, with production data.

Data Analytics and Decision Support Tools

A barrier to 'decision agriculture' is that it requires models and analytics to transform data into useful insights to aid better decision making.[34] For example, if farm data is available, including imagery, soil moisture, soil type and the make-up of species, is it possible to predict available feed next week or next month, and if so, how accurately? To fully benefit from data analytics, producers, services providers and agribusinesses need the skills to collect, store, analyse and share data, plus analytics capacity. A key challenge is data is usually available in 'silos' rather than 'lakes', so it is difficult to gain full value. To overcome this, it is necessary to design systems with open architectures and formats. The Australian Farm Institute modelled 79 percent of the possible productivity gains in the dairy sector from fully implementing data analytic and decision support agritech solutions.

Connectivity

Many agritech innovations rely on good internet connectivity to realise the full value of cloud based services for the collection and analysis of data. Connectivity enables applications to be used faster and at a lower cost than alternatives, for example, collecting on-farm data and transporting it to another location for analysis and inclusion in a larger data set. However, connectivity on farms or in the forest is often poor (or even non-existent) compared to urban areas. This is being addressed by many initiatives including the Government's Rural Broadband Initiative (RBI), developing private local broadband networks and investment in satellite-based internet services.

Trust and Legal Barriers

A lack of trust, confidence, safety, privacy and security are important factors affecting investment in agritech. The ownership and control of data is a particularly difficult barrier to overcome. The Australian Farm Institute states that the regulatory and legal framework for the collection use, storage and sharing of agricultural data is complex and fragmented and difficult to tackle as digital technology is changing so rapidly.[35] Meanwhile, New Zealand experiences similar challenges including how data is collected, owned, shared and stored. To

address these issues, contract terms governing agritech data needs to be fair and transparent.

The Business Case or Value of Investing in Agritech

The business case for investment in agritech is affected by a range of factors including level of capital needed, ongoing operating costs, potential profitability or return on investment. A detailed analysis of what influences farmers to engage in new agricultural practices[36] identified the following as critical factors:

- The relative advantage for farmers of new practices.
- How easily the new practice can be learned.
- The relative benefits of the new practice compared to existing practices.

While there is plenty of commentary on the benefits and risks of agritech empirical data on the financial benefits is lacking. This data is required to provide insights relating to their viability. However, recent research shows that the link between using precision agritech and profitability is specific to the situation in which it is used.[37]

The Australian Grains Research and Development Corporation (GRDC) research was based on case studies which looked at the costs and benefits using a range of precision agritech. A study on information and communication technology use in Australian agriculture found that farmer uptake was not only affected by farming type, but also the scale of the operation and the level of investment in information and communications technology (ICT).[38] [39] Another paper also highlighted the importance of farmer perceptions of agritech, including how these are formed and influenced.[40]

Research also indicates that the level of the initial capital cost was a key factor governing adoption of digital technologies. The significance of scale was also cited by the GRDC. Greater operating scale allows the necessary capital investment in hardware and software to be defrayed over more hectares, lowering the fixed cost, per hectare.

CRS SOFTWARE Helping Farmers Manage Cash

CRS Software has been developing farm financial software from its Wairarapa headquarters for 30 years.

In 1981, the company was born out of frustration, when three Wairarapa farmers figured there must be a better way to make informed decisions about tomorrow and be able to quickly change direction as necessary. It meant building more than just accounting software with the capacity to look backwards.

One of its products, Cash Manager Focus, is an award winning financial management platform for farmers. The cloud based apps lets farmers determine their current cash position, future cash positions, and predict their end of year position. The platform integrates with farming payroll platform Paysauce as well as with Fonterra's FarmSource reporting for Fonterra Dairy farmers.

The New Zealand Agritech Export Opportunity

Agritech exports present a significant opportunity as global demand grows.

The New Zealand agritech sector is relatively small by global standards. NZTE and Callaghan Innovation estimates there are around 950 agritech businesses in New Zealand.[41] Most agritech firms are working in the horticulture sector, followed by the dairy sector.

Callaghan Innovation and MBIE estimate that the export revenue from agritech has remained relatively flat for the last five years at approximately $1.2 billion.

The number of agritech firms and the volume of exports is slowly growing, however New Zealand lacks a 'superstar' billion dollar agritech business, says Callaghan Innovation. Currently, our largest is agri-innovation company Gallagher, with revenues of approximately $250 million per annum. Herd improvement firm Livestock Improvement Corporation (LIC) has revenues close to $150 million.

A 2014 report[42] indicates that New Zealand agritech businesses export primarily to Australia (~US$400 million per annum). This was followed by exports to the United States of America (~US$213 million), to China (US$74 million), Netherlands (US$73 million) and the United Kingdom (US$57 million).

Agritech Exporting Challenges

Fundamentally, agritech solutions designed for New Zealand may have limited application in global markets. Not all countries share our natural resources and temperate growing conditions.

For example, farmers in various different countries use different pastoral systems.

> ***Agritech has enabled improved productivity, quality and yield, it has yet to provide a breakthrough to the levels of sustained growth and value creation the sector would like to see. Nor has it adequately addressed a number of sustainability and environmental issues such as those around water quality, climate change and the provision of secure, high value jobs.***
>
> Agritech Industry Transformation Plan, 2020

Some locally designed solutions to improve fertilisation of pasture, may not apply in some overseas markets. In New Zealand, animals on farms are predominantly outside land based dwellers and primarily eat grass. In many other countries, farmers house animals in barns and they primarily eat grain. Many of New Zealand's agritech vendors focus primarily on the domestic market, without considering exporting. Some haven't sought overseas markets, while others haven't adapted their products for an overseas market. In some cases, it may be difficult to scale the solution for the international market.

Interestingly, non-agritech companies are also creating innovative agritech. For example, dairy ingredients supplier Fonterra has its own research

HALTER Providing Remote Herd Management

Halter combines their smart cow collar with an app that enables farmers to shift their herd remotely, set up virtual fences and monitor the health of their herd.

Each cow is fitted with a durable solar powered collar, removing the need to replace batteries. Sensory cues guide cows around the farm, supported by GPS to monitor precise location. Behavioural data, driven by AI is used to predict and alert when cows are on heat, lame or calving.

Using a cloud based mobile app, farmers can move all, or selected animals from one place to another using audio and vibration cues from the device. Halter will keep animals in a predefined space, for example, away from waterways without the need for fencing. The farmer can track locations in real and receive notifications on their smartphone.

The diverse team at Halter have worked on race cars, at NASA and on elite sports technology, but their roots are on the farm. Founded in 2016, Halter s aim is to reduce intensive hours farmers work, enhance animal welfare and protect the environment.

and development centre in Palmerston North. Fonterra creates agritech for itself, to create a competitive advantage. Recent innovations include ingredients that reduce allergy risk and high quality proteins for athletes.

Conversely, a recent KPMG scoping study[43] says that because the domestic agritech market is small, some companies are looking offshore earlier in their life cycle than is ideal. This can place pressure on their resources as they attempt to scale up. As a result, some will end up selling their business to an international company. This is a concern to our local industry because New Zealand loses the IP associated with the technology innovations.

The KPMG Scoping Study on Australasian agritech says that the local agritech industry is competitive and companies compete strongly against each other. However, this can lead to challenges in creating collaborations and information sharing. Partnerships are key and coalitions should include non-traditional investors, entrepreneurs, growers and government. Partnerships are highly beneficial, so the key question is how to foster collaboration in a competitive environment?

Collaboration rather than competition, should be sought but this will require companies to focus together on the global market, rather than competing against each other in the domestic market.

Opportunities Versus Risk

There is a trade-off for agritech businesses in choosing to export and the number of additional variables, including risks that the company must then manage. For example, domestic testing is generally not considered applicable in overseas markets. An initial exporting challenge is finding local people to demo and beta test your product. Two further risks are regulation and data standards.

Regulation

Strict regulatory settings can hinder attempts to register new products. This can lead to a lack of innovation because regulation is simply considered 'too hard'. Some innovations may stumble before they have taken their first commercial steps. International regulatory differences make it difficult for New Zealand agritech businesses to export. Agritech firms looking to export may need to invest resources into understanding the nuances of regulation in different markets.

New Zealand's international engagement systems, run by NZTE and the Ministry of Foreign Affairs and Trade (MFAT) have a key supporting role.

Data Standards

Understanding and complying with data standards globally may also be a barrier to agritech export. For example, the General Data Protection Regulation (GDPR) in Europe becomes another hurdle in seeking international markets, for an inexperienced entrepreneur. Consideration needs to be given to effectively providing local agritech companies with relevant information to 'go global'. Is there a better way to proactively help them manage potential barriers such as data standards and regulation?

ARGENTA Biotech and Life Science Manufacturing

Argenta was co founded in 2006 by chemist Dr Doug Cleverly.

From molecule to market, Argenta combines research and development with commercial scale manufacturing. They partner with customers to develop new chemical entities, original product ideas, conduct global clinical studies and manufacturing. Clients include animal health multinationals, emerging biotech and life sciences companies. Argenta now has subsidiaries and a manufacturing facility in the United States of America and another site in Scotland.

TABLE 1: New Zealand s Agritech Competitive Advantages

AGRIBUSINESS HERITAGE	FREE & OPEN MARKETS	AGRIFOOD BUSINESS MODEL	GEOGRAPHIC ADVANTAGES	GOVERNMENT/ POLICY ADVANTAGES	SOCIAL ADVANTAGES
- strong global supply chains. - clean, green heritage.	- Active in Free Trade Agreements (FTA)s & World Trade Organisation (WTO) engagement. - FTAs with China, CPTTP & Europe.	- national cooperatives providing global scale.	- island nation borders protected by distance. - East/West cross roads. - multiple growing climates.	- #1 globally for ease of doing business. - proactive Government support for the sector.	- small connected and collaborative ecosystem. - Māori world view aligned with global megatrends.

Source: Agritech New Zealand, 2020

New Zealand's Advantage – Our Global Market Opportunity

New Zealand geographic, economic, social and policy benefits provide our agritech industry with a unique competitive advantage on the world stage. Leveraged well, these advantages will facilitate favourable conditions for agritech sector growth. They can enable New Zealand to address global megatrends and develop world leading agritech solutions.

New Zealand's competitive, economic and brand advantages are detailed in the following table:

TRU-TEST Electronic Milk Meters

Kiwi farmer John Hartstone invented the milk meter in 1963. Before his invention, dairy farmers struggled to accurately measure milk output from individual cows.

The visibility of individual output allows farmers to select cows with higher outputs for breeding. Since the Tru Test milk meter s invention, average herd output per hectare of land has doubled in New Zealand. The Tru Test meter is mass produced and holds the majority share in the global milk meter market. This deceptively simple invention has enabled growth in productivity from dairy herds in New Zealand and around the world.

Tru Test now produces electronic milk meters with data recording and analytical capabilities.

Our Reputational Heritage

New Zealand already has a strong brand and global reputation for excellence in agribusiness. The country also continues to be perceived as 'clean and green'. The agritech sector can leverage this reputational heritage into the tech innovation industry.

Existing agricultural success combined with strengths in the food and beverage sectors affords New Zealand with excellent links in global food supply chains and distribution models. A heritage of success means there is a pool of domain knowledge from which agritech companies can further innovate.

Free and Open Markets

New Zealand has broad preferential access to global markets via a number of favourable term trade agreements. For example:

- The Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) which is a free trade agreement involving 11 Asia Pacific countries including Australia, Japan, Singapore, Canada, Malaysia and New Zealand. New Zealand's Foreign Affairs and Trade says the other countries are the destination for 30 percent of New Zealand's export goods and 30 percent of New Zealand's export services. The agreement was signed in 2018.
- The New Zealand - China Free Trade Agreement. In 2008, New Zealand and China first signed a free trade agreement, which has grown in size over the years. The 2008 agreement eliminated tariffs for over 97 percent of New Zealand goods exports to China. It provides better access for New Zealand service providers into Chinese markets and reduces compliance for some electronic or electrical items.

There is additional work underway to expand trade access through additional agreements. For example the free trade agreement (FTA) with the European Union (28 countries including the United Kingdom, France, Germany, Italy, and the Netherlands). New Zealand proposed the FTA in 2009 and in 2018 formal negotiations were launched and these could take two to three years. New Zealand's FTA goals include the removal of tariffs and other cost barriers.

Agrifood Business Models

New Zealand business models in the agrifood sector can provide a competitive advantage on the world stage as noted in the New Zealand Government's Industry Transformation Plan for the Agritech sector.

Agri cooperatives include Fonterra, Silver Fern Farms, Farmlands Cooperatives, Ballance Agri-Nutrients and Ravensdown. Their size enables economies of scale and deeper pockets for

> ***There are a significant number of organisations across the primary sector that are run as cooperatives. Notwithstanding pressures around debt repayment and the need to maintain dividends and pay out, cooperatives are generally less focused on short-term performance for stock price gains, they are more able to invest for the long term.***
>
> Agritech Industry
> Transformation Plan, 2020

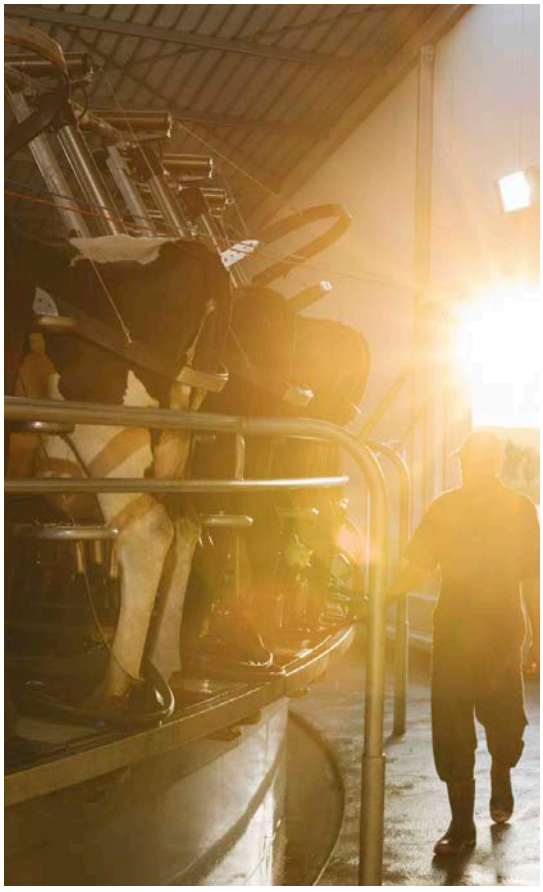
SIMCRO Animal Health Delivery Systems

Waikato based Simcro is an agritech firm focused on animal health delivery systems including drenchers and vaccinators. The company takes a data driven approach to animal health with its livestock management platform. In 2018, Datamars, a 100 year old listed company in Sweden, invested in Simcro to boost production capability and extend product verticalization.

Datamars specialises in radio frequency identification with markets in companion animal ID, livestock ID and textile ID products. The investment integrates the two businesses and expands Simcros market reach and product portfolio.

investment into research and development. A 2017 report by Cooperative Business New Zealand[44] found that New Zealand's top 30 cooperatives contributed more than $42.3 billion revenue per annum to the economy. The report compared the countries with the top 300 cooperatives in the world. The agrifood sector in New Zealand accounts for twice as much of New Zealand's cooperative economy as the average of the top 300 cooperatives globally. Most countries have large financial services cooperatives and small agri-cooperatives. This suggests that our cooperative model in agribusiness punches above its weight relative to other countries.

Smaller agritech businesses also have an advantage. Due to the size of New Zealand's economy, many startup companies have a history of bootstrapping, building up a company from nothing. Large amounts of investment capital are difficult to find, so when a New Zealand innovation is commercialised, it is likely to be very good. The reality in New Zealand's economy is that there's simply not enough money to spend developing substandard solutions.



Geographic Advantages

Despite the 'tyranny of distance,' New Zealand's status as a relatively small, geographically isolated island nation in the southern hemisphere is advantageous.

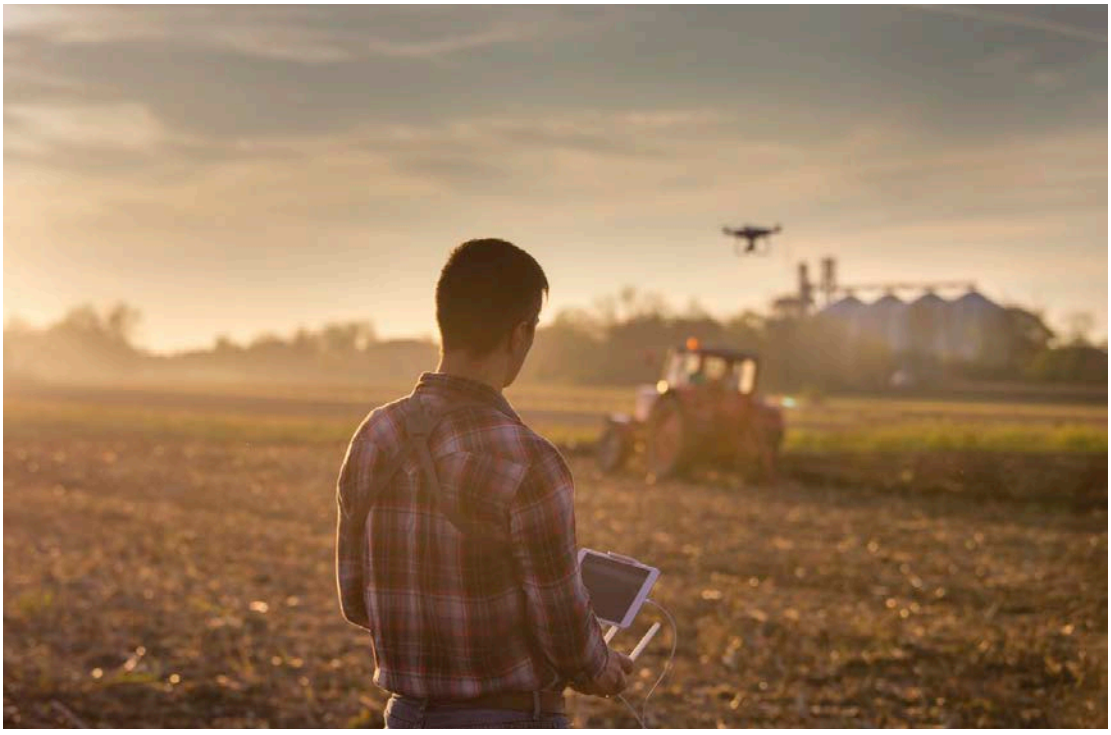
From a trade perspective, New Zealand is well positioned between the West and the East.

This provides New Zealand with three distinct advantages. Firstly, businesses are able to build contacts and relationships across the East and West, and cross pollinate those relationships. Secondly, New Zealand crosses business hours with both the East and the West. Thirdly, with consideration to diverse cultures and lifestyles, particularly in the food sector, this creates market diversity for New Zealand businesses.

Island nation status means New Zealand is less at risk from political or other cross-border tensions. From a political perspective, combined with a stable and supportive political environment and a neutral political stance with most other countries, New Zealand companies are attractive to do business with.

New Zealand's geography means there is a range of temperate growing conditions from subtropical to cool temperate. The west of New Zealand is relatively wet, the east is relatively dry and other places such as Alexandra in Central Otago are semi-arid. This provides agritech vendors with a wide range of climates to test agri innovation.

Another advantage for testing agri innovation is New Zealand's southern hemisphere location.



New Zealand is counter seasonal to northern hemisphere locations in Europe, North America and Asia. By collaborating with Northern Hemisphere markets, New Zealand agritech businesses can successfully conduct two R&D field testing seasons per year.

Governmental and Policy Advantages

The World Bank ranks New Zealand as number one in terms of 'ease of doing business,[45] meaning it is easy to set up and run a business. New Zealand has effective regulation in place that is also easy to follow and understand. This means it is easier in New Zealand for agritech companies to establish themselves as a business and to run their business administration, for example, filing tax returns.

Since the 1984 removal of subsidies, farmers needed to cut costs, find ways to be more productive and create new products. Now, New Zealand farms have been operating for over 35 years without subsidies which has driven an agile and innovative style of farming.

Social Advantages

New Zealand is a cohesive and well connected society. Despite an increasing population, the idiom of 'Two degrees of separation' is strong and everyone knows someone, who knows someone, who can fix your problem! New Zealanders have strong ties to the land. There are communities of tangata whenua whose ties to the land and to agriculture have been passed down for generations and provide a unique perspective.

There is a relatively small agritech business ecosystem in New Zealand. This should be harnessed to encourage collaboration and communication, rather than competition.

With a relatively small population, New Zealand can be agile and innovative. New Zealand is less likely than other countries to experience a disconnection between technological innovation and real work problems. In comparison, anecdotal evidence from Californian food producers to a New Zealand agritech delegation suggests that some startups seldom venture into Salinas Valley to speak to farmers to find out what problems they need to solve.

_PART THREE

Unleashing Aotearoa's Agritech

51

Growing our Agritech Sector in a Post COVID-19 World

The alignment of policy, investment and skills development will ensure New Zealand is well placed in the future for competitive advantage. The potential increase in exports, will also increase productivity and reduce environmental impact.

The COVID-19 pandemic has raised additional challenges for New Zealand's agritech sector. Closed borders mean that accessing offshore markets has become difficult, particularly for businesses that were ready pre-COVID-19 to investigate new market development opportunities.

The Agritech New Zealand Insights survey of the sector during Alert Levels 3 and 4 revealed that 50 percent of agritech businesses rated access to offshore markets as being more challenging. For larger agritech businesses who already had offshore bases, the impact was less severe. However, once border controls have been removed, it's likely it will take time to rebuild some of these new market development strategies.

The same dynamic is also impacting inbound venture investment. Anecdotally, it is anticipated that it will be 2021, before any significant increase in offshore venture investment is seen in New Zealand agritech businesses.

Despite closed borders and the global impact of COVID-19, there are other opportunities to consider. The creation of a single trans-Tasman 'bubble' is a good example. As global supply chains are disrupted, we are likely to see increased investment in regional supply chains. New Zealand agritech companies are well placed in this regard. The establishment of the Australia New Zealand Agritech Council in September 2019 at the Auckland Australia New Zealand Leadership Forum (ANZLF) meeting, is providing support for this work.

Undoubtedly, the most significant recent development for the agritech sector was the announcement of $11.4 million funding support for the Agritech Industry Transformation Plan (ITP) in the Government's Budget 2020. The Agritech ITP contains several work streams, designed to support the growth and scaling of our agritech community. It addresses crucial issues including commercialisation, skills and training, investment, global opportunities, data standards and regulation. High impact projects including the establishment of a Robotics and Automation Academy, provide the sector with the opportunity to develop a global thought leadership position across key aspects of agritech.

Many elements of these work streams will help transition the sector to a post-COVID-19 world. Compared to other countries, the successful implementation and delivery of the Agritech ITP will help scale New Zealand's agritech sector at a challenging time for most. It will also play a highly critical role in supporting our major competitive advantages.

Currently, agritech businesses tend to solve domestic challenges and work competitively. The key to leveraging our competitive advantage is in understanding which global agritech problems are valuable to solve. We are a relatively small country so the key question is how do we pool our agritech resources to make an impact on the world?

An Ecosystem of Support

Growing the agritech sector and the resulting economic benefits will take the entire ecosystem, industry, Government and research working together.

Investment in R&D by New Zealand's food and fibre sector has been identified[46] as an opportunity for the New Zealand agritech sector. In 2018, $640 million was spent on food and fibre R&D[47] across industry and Government, making up one third of Government R&D spending. This shows there is an existing complimentary research ecosystem and a culture of R&D in the primary sector.

Likewise, while there is a general lack of growth capital in the New Zealand technology sector, there is a growing investment ecosystem. The Government's recent announcement of a new $300m venture capital investment fund is welcome, but further work will be required to attract additional necessary capital and expertise.

The Industry Ecosystem

Despite agriculture and the primary sector being the largest contributors to New Zealand's economy, the agritech sector has, until recently, been disorganised and fragmented. During 2017, a group of industry and Government stakeholders identified one of the major challenges facing the agritech sector was the lack of a strong industry coordinating entity. In 2018, Agritech New Zealand was launched as a not-for-profit, member funded association to help coordinate and represent the agritech ecosystem.

Launched as an association within the New Zealand Tech Alliance, Agritech New Zealand is now one of 20 connected tech associations that collectively represent over 1,500 members, employing more than 10 percent of the New Zealand workforce.

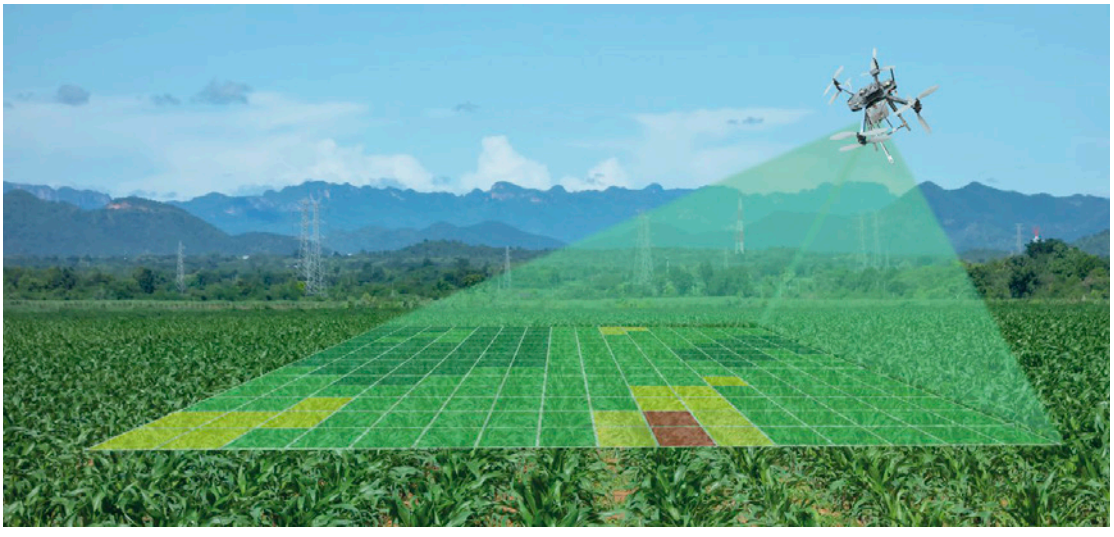
Throughout 2019 and 2020, Agritech New Zealand has proactively collaborated with other industry stakeholders, connecting its growing membership to the development of the Government's Agritech ITP. During 2020, the New Zealand agritech ecosystem continued to mature with the merger of Agritech New Zealand and the Precision Agriculture Association of New Zealand (PAANZ). This ecosystem now includes most major agri-businesses in New Zealand, research organisations, international and local technology companies, Government agencies, farmer practitioners and startups.

The Research Ecosystem

While New Zealand universities and Crown Research Institutes (CRIs) undertake a considerable amount of research in the food and fibre space, they are not well known for commercialising their innovations. There appears to be a lack of connection between research and the market.

However, New Zealand is lucky to have a vibrant and diverse research sector for agriculture. The key is to streamline distinct research areas and create a fast path to commercialisation.

- **Lincoln University**, New Zealand's smallest university, specialises in agricultural and environmental study on a land based campus. Recently, a research team developed nano-coating for seeds and fertilisers. This enables farmers to better control the release rate of fertilisers into soil and delay seed germination. The revolutionary technology reduces farming costs and negative environmental impacts, as well as improving productivity.
- **Blinc**, (previously called Lincoln Hub), connects people, ideas, technology, and resources for innovative naturetech solutions. Blinc works with organisations, startups, researchers, growers, and universities, providing co-working workshop space to facilitate this. Blinc has fostered collaboration between local researchers and Canterbury based company United Fisheries. Together they have created a process using fish silage (a by-product of the filleting process) to add fish oil to dairy cow diets. This low waste solution reduces methane emissions and supports herd health.
- **Massey University**, New Zealand's second largest university, has campuses in Palmerston North, Wellington and Auckland. Massey runs the country's highest-ranking agriculture programme. The university's Riddet Institute has created a food technology to combat iron deficiencies. FERRI PRO adds iron to foods without affecting quality or taste. The product has already seen commercial success with Nestle buying the patent for FERRI PRO in 2019.



- **The University of Auckland**, New Zealand's largest university, has an agritech programme combining practical experience and research in sciences, engineering and business. For example, the collaboration resulting in the Autonomous Multipurpose Mobile Platform (AMMP), designed to pollinate and harvest kiwifruit. Auckland University's Centre for Automation and Robotic Engineering Science partnered with company RoboticsPlus for this project. Automated pollination and harvesting means kiwifruit growers can navigate labour shortages and declining bee populations, and maximise production.
- **University of Waikato**, based in Hamilton, has a strong connection with agriculture and agritech research produced from food technology, robotics, smart machinery and agri-business management. A University of Waikato research team engineered a smart machine designed to accurately drill holes for pine cuttings, ensuring they grow straight. The dibbler improves productivity and minimises waste. It is fully computer controlled, adjustable to both tree and soil type.
- **University of Otago**, New Zealand's oldest university, has world class facilities including the Mellor Clean Laboratory. The university's agricultural programme draws on research expertise in microbiology, immunology, biochemistry, food science, sociology and industry management. Otago researchers are working to develop a type of non-flowering ryegrass. Flowering ryegrass is less nutritious for livestock. Otago's ryegrass cultivars are engineered to flower in artificial conditions, but not in-field. This promotes year-round peak production for farmers and optimal grazing conditions for herds.
- **The New Zealand Agricultural Greenhouse Gas Research Centr**e (NZAGRC) was founded in 2010, specialising in agricultural greenhouse gas mitigation research and supporting the sector's profitability for New Zealand. The NZAGRC's Methane Emission Mitigation programme has developed a new methane measurement technique. The Methane SF6 tracer technique measures the amount of methane produced by a freely grazing animal in a given feeding cycle. Sulphur hexafluoride (SF6) gas is inserted into an animal's rumen via a tube, and a canister near its mouth draws in SF6 and methane when the animal belches. Scientists can measure the ratio of methane to the known quantity of SF6 to calculate methane release. Researchers can take these measurements under realistic conditions and long periods of time. This is an important tool for NZAGRC's low methane breeding programmes.
- **The New Zealand Institute of Agricultural and Horticultural Science** (NZIAHS) is an independent, professional society. It works to promote agricultural and horticultural development in New Zealand. NZIAHS innovates in the fresh food industry. Research into Dynamic Controlled Atmosphere conditions for New Zealand's Hass avocados has prolonged storage life, reduced rot and shortened post-storage ripening time. This enables New Zealand growers to export products to more distant markets and ensure quality.
- **AgResearch** is a New Zealand Crown Research Institute founded in 1992. Its science and technology research aims to benefit New Zealand agriculture and the wider economy and society. The institute develops

pastoral agriculture solutions in areas such as pasture seeds, pest control and high value food production. The Forage Science division has integrated drone and chemical signature identification technologies to 'map and zap' weeds with targeted lasers. The aim is to reduce aggressive pesticide and chemical use.

- **Plant and Food Research** is a Crown Research Institute established in 2008. Plant and Food Research aims to grow plant and marine food industries through applying and commercialising research based innovations. For example, scientists have accelerated kiwifruit flowering, using CRISPR gene editing technology to edit growth-repressing genes. This breakthrough could transform kiwifruit into a compact, continuously flowering plant, suitable for indoor farming. This will transform revenue, yield and land use in the kiwifruit industry.
- **SCION**, is a Rotorua based research institute, also known as the New Zealand Forest Research Institute. This Crown Research Institute was founded in 1992 and specialises in forestry and plant biomaterials. Scion created compostable utensils out of kiwifruit waste. The biodegradable spife, a combination spoon and knife, is now sold with packaged kiwifruit. Just one kiwifruit can make up to 100 bioplastic utensils.
- **Landcare Research (Manaaki Whenua)**, another Crown Research Institute, was established in 1992. Its focus is the protection and enhancement of New Zealand land environments. Science teams work in biodiversity, biosecurity, sustainable development and land health. It is developing several agritech solutions for pest control in New Zealand, for example, a species selective toxin, specific only to rats. Researchers have also employed AI in image recognition software to automatically identify animals in trap and trail camera images.
- **The Institute of Environmental Science and Research (ESR)** is a Crown Research Institute, founded in 1992. It focuses on providing scientific and technological solutions in forensic science, public health and environmental health. Its newest innovation reduces the presence of nitrates in groundwater systems. ESR is trialling woodchip denitrification wall technology in a gravel aquifer in Kaiapoi. The project is the first of its kind.
- **Sprout** is an agricultural accelerator and advisory, dedicated to advancing growth for New Zealand business in the agricultural and future food sectors. Sprout recently partnered with Next Farm to engineer a smart irrigation solution. Their irrigation control system allows for more efficient and sustainable water management. Farmers can control individual irrigators through a cloud-based software to minimise run-off and wastage.

The Capital and Investment Ecosystem

New Zealand has an extensive funding and investment ecosystem. There are a number of Government agencies providing research and investment funding as seen in figure 5. In May 2019, the Government announced a new $300 million venture capital fund. The aim is to attract private sector investors to the domestic venture capital market to help early stage innovative New Zealand companies to grow. It's aim is to also "keep more startups in New Zealand for longer," said Minister David Parker. The fund's lifespan is 15 years and it will return the value of the investments to the Government to help pay for superannuation.

FIGURE 5: New Zealand Government s Main Expenditures On Science And Innovation

Who manages the funding?

MPI (Vote Primary Industries) Callaghan Innovation (Vote B, S+I) TEC (Vote tertiary Education)
HRC (Vote B, S+I) MBIE (Vote B, S+I) Other departmental (MPI, MfE, DOC) Royal Society (Vote B, S+I)

Note: Indicative, Based On Latest Data
Source: National Statement of Science Investment, 2015–2025, Ministry of Business, Innovation and Employment (MBIE.), October 2015.

Some of the funds currently available for the agritech sector include:

- **The New Zealand Growth Capital Partners (NZGCP).** Formerly known as New Zealand Venture Investment Fund (NZVIF), is an early stage equity investment programme. This fund aims to stimulate a well-functioning capital market for early stage technology companies via two investment vehicles. Both are designed to stimulate private investment through fund of funds (FOF) and co-investment models.
- **The Pre-Seed Accelerator Fund (PSAF) by MBIE.** This fund supports early stage technology commercialisation, maximising commercial benefits from publicly funded research. It also improves the commercial capability and skills of public research organisations and promotes linkages between public research organizations and potential private sector partners.
- **Marsden Fund.** The Royal Society administers the Marsden Fund to support science and humanities research in New Zealand. Recent grants include a study leading to the discovery of a new class of flavonoids and a study on the magnitude of sea-level changes.
- **The Endeavour Fund.** This fund supports research with the potential to positively transform New Zealand's future. Funding is available through Smart Ideas and Research Programmes. Smart Ideas rapidly tests promising innovative research ideas. Research Programmes support ambitious, excellent and well defined ideas.
- **Callaghan Innovation.** Callaghan Innovation supports R&D with project grants and aims to increase expenditure to two percent of GDP by 2027. To support this mission it has placed 200 scientists and engineers near Wellington for science-as-a-service. Callaghan also has programmes in place to improve businesses' capability and innovation skills. This includes emerging technology workshops. In addition, Callaghan has dedicated customer managers for agritech businesses.
- **Ministry for Primary Industries (MPI) Sustainable Food and Fibre Futures (SFF Futures) program.** The SFF Futures supports innovative problem solving in New Zealand's primary sector by co-investing in initiatives that make a positive difference. With $9.8 million in funding, farmers, growers and foresters work towards economic, environmental and social sustainability in the primary sector.
- **Green Investment Fund.** This is part of the Government's commitment to address climate change and support our transition towards a net zero emissions economy by 2050.
- **Provincial Growth Fund (PGF).** The New Zealand Government has allocated $3 billion over a three year term to invest in regional economic development. Through this fund, the Government aims to address the digital divide by helping build an inclusive, productive and sustainable regional economy.
- **Strategic Science Investment Fund.** The Strategic Science Investment Fund (SSIF) funds investment in research programmes and scientific infrastructure that have a long term beneficial impact on New Zealand's health, economy, environment and society.
- **Regional Research Institute Fund by MBIE (RRI).** Aimed at enhancing regional advantage, the RRI established new, independently governed, private, or private not-for-profit regional research institutes.

A Sector Transformation Plan

Launched by the Government in 2020, the Agritech in New Zealand Industry Transformation Plan (ITP) is a response to the growing recognition of the importance of agritech for New Zealand's continued primary sector growth and prosperity.

The ITP acknowledges the importance of a cohesive approach to supporting and developing the agritech ecosystem in order to enable this growth.

The Government's Budget 2020 allocated $11.4 million towards supporting the activation of the ITP over the next two years.

The ITP includes a series of actions broadly grouped into six workstreams, plus three proposed high impact projects. Further details of the ITP workstreams and initiatives can be accessed online from the Ministry of Business, Innovation and Employment.[48]

Agritech ITP budget

$11.4m

With an organised ecosystem, the New Zealand agritech sector is well placed to better coordinate, grow and lift exports. During the last 12 months, the Government has worked closely with industry to develop this extensive plan. However, in the post-COVID-19 world new challenges and opportunities will emerge.

High Impact Projects

- Horticultural Robotics Academy.
- Hosting the Farm2050 Nutrient Initiative.
- Creation of a specialist agritech venture capital fund.

Global Workstream

- Connecting the New Zealand agritech ecosystem to global opportunities.
- Learning from global agritech leaders.
- Collaborating with Australia.

Commercialisation Workstream

- Accelerating commercialisation of research institute IP.
- On farm technology prototyping.
- International research collaboration.

Investment Workstream

- Specialist early stage capital funding.
- Maximising global funding links and opportunities.

Data Interoperability and Regulations Workstream

- Data interoperability and open data.
- International and regional variations in regulatory standards and requirements.

Skills and Workforce Workstream

- Skills required to develop agritech.
- Skills required to use agritech.
- The impact of agritech on the workforce.

Government Workstream

- Promoting and improving transparency of Government support.
- Encouraging communication and streamlining across Government.
- Improving understanding of the agritech sector.

Recommendations

This study has reinforced just how much opportunity is at stake for New Zealand if we get this right.

A coordinated, growing agritech sector not only offers significant export growth opportunity, it can also deliver much needed productivity growth.

Even though the ITP was developed pre-COVID-19, it still provides an excellent framework for sector growth through collaboration and investment. This study endorses the recommendations and proposed action plan of the ITP. However, additional opportunities have since emerged and offers the following recommendations:

Strengthen Commitment to the National Agritech Strategy

The ITP provides the ideal platform to address some of New Zealand's major agritech challenges and transform them into opportunities. While it currently appears as a Government document, it was developed collaboratively with industry and this needs to be better identified and highlighted. Strengthening commitment in this way will help ensure that both industry and Government regularly revisit the strategy and challenge the sector.

Recommendation:
Clearly identify the ITP as the New Zealand Agritech Strategy. Consider publishing a summary document to further highlight industry collaboration. Design the strategy for a broader audience to help sell New Zealand s collaboration, ingenuity and leadership across the sector, to the public, and to the world.

Develop a Trans-Tasman Agritech Strategy

As we move towards a post-COVID-19 world, the importance of building regional supply chains is critical. As recent events have shown, the impact of closed borders on international trade is significant. The potential for a more open trans-Tasman border, brings opportunities to not only access each other's markets, but to collaborate and penetrate global markets.

The creation of the Australia New Zealand Agritech Council is a first step towards this, however a more detailed understanding of the strengths and synergies between both countries' agritech sectors is required.

Many New Zealand agritech companies have strong export sales across the Tasman and have developed excellent networks. While trans-Tasman research cooperation exists between some entities, for example CSIRO and AgResearch, there is no shared strategic plan.

Recommendation:
Develop a trans Tasman agritech strategy to help industry and Government effectively align for shared regional opportunities.

Understand Local Agritech Adoption Better

This study has identified the significant economic benefits that could be accrued for the New Zealand economy through increased uptake of agritech by the local primary sector. However, the research was based on data from the Australian market (modelled to local conditions) due to a complete lack of data available in terms of local agritech adoption.

The research also identified that adoption is often driven by advice from peers and trusted local partners. The ITP commercialisation workstream is addressing this by assessing the viability of demo or test farms. This will go some way to helping, however the breadth of possible agritech solutions across the primary sector is enormous. As a country we should consider the value in capturing what agritech is currently deployed, the value it is bringing and how this changes over time. This will help the Government better target its support funding and help practitioners identify best practices.

Recommendation:

Audit current agritech uptake across the country. Consider designing the audit as a longitudinal study to help track and identify economic benefits.

Stimulate Local Agritech Adoption

Businesses can be slow to change and agriculture is no exception. However, in many cases the potential change has broader benefits, for example environmental improvements. According to KPMG,[49] only 20 percent of irrigation systems in Canterbury use variable rate technology despite the fact that the economic payback for farmers alone makes sense. KPMG have estimated that full deployment of variable irrigation technology could save Canterbury farmers over 250 billion litres of water annually. The evidence is there for farmers to transition to a more sustainable approach but there needs to be a coordinated communication effort to share unbiased, trusted information.

Recommendation:

Consider mandating technology adoption where it makes sense, for example, for environmental benefits. The Practitioner Working Group within Agritech New Zealand can play a lead role alongside the Government in developing advice and engaging with the farmers and growers.

The Research Team

AgriTech

Launched in 2018, AgriTech New Zealand is a purpose driven, membership funded organisation whose members share a passion for the opportunities that agritech can generate. AgriTech New Zealand connects innovators, investors, regulators, researchers and interested public. It promotes opportunities and challenges raised by agritech. AgriTech New Zealand advances the ecosystem through advocacy, collaboration, innovation, talent and economic growth through international connections and missions.

Agritech New Zealand analysed and edited this report.

NZTech

NZTech is the voice of the New Zealand technology sector. NZTech represents over 1,000 organisations across the technology landscape in New Zealand, from startups and local tech firms to multinationals, and from ICT to high tech manufacturing. NZTech's goal is to stimulate an environment where technology provides important productivity and economic benefits for New Zealand.

NZTech provided further analysis and peer review for this report.

IDC

IDC is a global provider of market intelligence, advisory services, and events for the information technology, telecommunications, and consumer technology markets. With more than 1,100 analysts worldwide, IDC offers global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries.

IDC collated local and international research for this report.

Sapere Research Group

Sapere Research Group is one of the largest expert services firms in Australasia. Sapere provides independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

Sapere conducted economic analysis and research for this report.

Research Methodology

Agritech New Zealand COVID-19 Insights Survey

From 31 March – 9 April, 2020, during New Zealand's COVID-19 Alert Level 4 lockdown, Agritech New Zealand surveyed the New Zealand agritech sector. The purpose of the survey was to gain a better understanding of the sector's resilience and business continuity planning, during COVID-19 alert levels and beyond. Survey results were used to help Agritech New Zealand identify new measures to assist local agritech businesses navigate New Zealand's planned economic recovery.

Methodology

Survey Monkey was used to gather respondents' answers through a combination of open and closed questions. Agritech New Zealand engagedThematic (www.getthematic.com), a New Zealand owned, but San Francisco based text analytics company, to gain insights from open answers. The survey attracted 121 respondents, or approximately 12 percent of the sector. The respondents included large corporations, SMEs, startups, research organisations and support services. Sixty percent were agritech companies and 40 percent academic or support organisations.

Economic Analysis – Methodology and Details

Economic consultancy Sapere undertook an analysis of the gap between the current level of production and what could be achieved if the best agritech systems and technologies were applied. In many cases, agritech systems and technologies are in experimental stages, so information on their productivity potential is only emerging. However, despite the limitations, Sapere were able to establish the potential economic benefit of increased use of agritech in New Zealand. A literature search of academic and industry sources, papers by industry experts and benchmarking studies also provided a useful source of data.

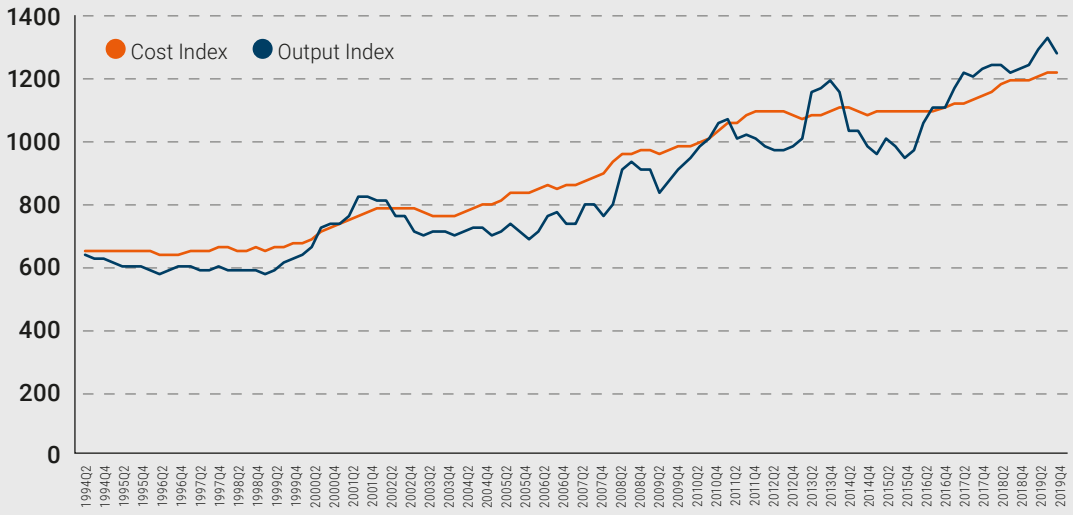
The Importance of Productivity in the Primary Sector

Productivity is important for the New Zealand agricultural sector as a key measure of industry performance and profitability on farms, in the forest or in the ocean. In the primary sector, the level of productivity reflects the efficiency participants use, where relevant, land, labour, capital and intermediate inputs (for example, chemicals, fertilisers, fuel and irrigation) for production. Improvements to productivity are achieved when the outputs (production) increase compared to the total level of inputs (for example fertiliser, fuel and labour).

Figure 6 below shows the pattern of quarterly Producers Price Index (PPI)[50] for input prices compared to output prices for the agriculture, forestry and fishing sector over the last 25 years, from the second quarter of 1994 to the fourth quarter of 2019. Clearly New Zealand's primary sector has had long periods where input costs have exceeded output prices, such as 1990s and 2000s and short periods where the sector has been more profitable, for example, 2001, 2011, 2013/14 and since 2017.

By improving productivity, producing 'more with less', farmers, foresters and fishers are able to remain profitable, despite often challenging relative prices of inputs and outputs.[51] As in other sectors, using new technology can enhance productivity and profitability as inputs convert to outputs more productively, increasing receipts

FIGURE 6: Farming Forestry and Fishing Input and Output Producers Price Indices 1994 to 2019



Source: Stats NZ, Inforshare : Table: Inputs and Output (ANZSIC06) - NZSIOC level 1, Base: Dec. 2010 quarter (=1000) (Quarterly -Mar/Jun/Sep/Dec)

(output price times output quantity), and/or reducing costs (input price times input quantity).

The data highlights the ongoing struggle to improve productivity and profitability. New Zealand must aim to capitalise on its competitive advantages and apply agritech solutions wisely where there is the greatest expectation of good returns. It must aim to do a better job than its key competitors in the long run.

Estimating the Value of Agritech

Estimates of improved productivity from applying agritech in Australia were calculated using the Centre for International Economics Regions Food Processing Model (CIE RFP). Each projected effect of the use of 'decision agriculture' was applied to a base level of primary sector production. This allowed the potential total output to be estimated, if all agritech was applied. The projected effects were assessed through a combination of academic and industry literature, consultation with the Rural Research and Development Corporation representatives and industry experts, benchmarking studies and industry workshops that were held as part of the Accelerating Precision Agriculture to Decision Agriculture programme.[52] There are a variety of other studies that address benefits of agritech including Digital Technologies in Agriculture,[53] Precision Farming with Digital Agriculture,[54] and Benefits and costs of entry level precision agriculture technologies.[55]

Agritech Value for the Grain Sector

If agritech solutions were fully implemented in grain farming, the Australian Farm Institute

study estimated that a 51 percent improvement in output would be possible. The high gain is attributed to the intensive nature and high cost of production of these enterprises. This level of output response could be optimistic for New Zealand, given the smaller scale of grain growing enterprises and associated transport and distribution networks.

The single greatest contributor to the increase in output was expected from improvements in crop rotation (15 percent). This was thought to flow from farmer's use of soil water sensing and seasonal forecasting analytics and data on the impacts of previous crops to be able to optimise the sequence of crops to plant. In New Zealand, case studies show significant gains are possible from use of similar agritech solutions. For example, Otago's Mitchell and Webster Group's use of variable rate irrigation technology and electro-magnetic maps.[56]

The next largest contributing agritech solution in the Australian Farm Institute study was better planting which was predicted to provide a 10 percent uplift in output. This was due to better matching crop varieties with soil types and geography to maximise yield and quality. In addition, it is possible to improve yields from variable rate seeding and time of sowing. Optimising crop nutrition was predicted to unlock a nine percent increase in output from using a range to agritech to match nutrients better to crop sites. Yield forecasting could lift output by six percent. This estimate was based on more accurate forecasting using remote sensing allowing higher confidence levels for marketing and higher prices to be achieved by taking advantage of market opportunities. A more modest output response was thought possible from better fallow preparation using selective spraying based on real-time sensing and maps of previous weed distribution.

Agritech Value for the Livestock Sector

It was estimated that productivity gains possible from fully utilising agritech would be between 32 percent in dairying (not including dairy product manufacturing) to 38 percent for sheepmeat and wool. Improvements in breeding decisions contributed significantly across livestock production, except for pork production. It was thought to be the single largest potential contributor to productivity in beef and sheepmeat production and one of the two largest contributors in dairying. Significantly, improved breeding decisions offer significant gains with modest increases in inputs or capital.

Variable rate pasture management was an important factor in the dairying sector (10 percent better productivity) while feed, landscape and water management were major contributors to the gains possible from the beef, sheepmeat and wool sectors (between 10 and 12 percent). Improvements from animal health and disease monitoring were material for sheepmeat and wool (10 percent) but were thought to make a lesser contribution to the dairying and beef sectors.

In the meat processing sector, the Australian Farm Institute report identified technologies that focus on carcase measurement and feedback systems as the most promising. These agritech solutions could help farmers meet quality assurance standards and grading specifications such as for weight, stress, as indicated by pH and dark cutting, disease identification and feedback. Other agritech included farm level real time objective measurement such as walk through weight/body composition scanners and feed measurement solutions.

A recent New Zealand study of investment preferences of dairy farmers for automation compared to decision support technology indicated the potential benefits. For example, rotary dairies, with a mix of automatic cup removers, automatic teat spraying and automatic drafting were associated with 43 percent higher labour efficiency and 14 percent higher milking efficiency compared to rotary dairies without these technologies.[57] In addition, this study highlighted the potential from implementing some of these technologies as 56 percent of farmers with herringbone dairy parlours had none of the automation or decision support technologies investigated. This was echoed by DairyNZ in its submission to the Productivity Commission's investigation of Technology adoption by firms.[58] It stated that "fully automated milking represents a large opportunity for farmers, but currently adoption is low (about 25 farms in total) due to factors such as cost of technology and poor fit with large pasture-based dairy farming."[59]

Agritech Value for the Horticulture Sector

The Australian Farm Institute study showed if agritech was applied fully to the horticultural sector it could increase output by almost 40 percent. Half of this was due to the benefits of using data to reduce losses in storage, handling and transport. For example, it predicted 20 percent higher productivity from better vegetable storage, due to monitoring and remote sensing reducing wastage.[60] Other important contributions were made by improving crop nutrition, planting and labour efficiencies.[61] Automation and robotics applied to planning, crop monitoring and harvesting were estimated to reduce labour costs by 30 percent.[62]

This study identified that the horticultural sector had a substantial opportunity to improve supply chain efficiencies using digital technologies because a level of product wastage was estimated at 15 percent of gross production. The levels of waste in New Zealand's horticulture may be comparable. According to Horticulture New Zealand (2017)[63] fresh vegetable wastage, comprising a third of total food waste, was around $45 million per annum. Further investigation would help identify the potential savings from the whole horticultural sector.

The Australian Farm Institute study listed several agritech solutions which could improve productivity including automated crop health monitoring, autonomous weed management, sensing networks, robotic harvesting, increased packing line and shed efficiency and pest management. In New Zealand, Zespri is investigating robotics and precision horticulture to combat rising labour costs and reduce waste.[64]

Agritech Value for Vertically Integrated Industries

These sectors, which included poultry, wine and forestry sectors, were difficult to disaggregate between pre-farm gate and post-farm gate activities. In Australia, as well as New Zealand, a number of the larger participants in these industries operate along most of the supply chain.

Viticulture

The most significant gains in productivity were assumed to derive from better prediction of wine quantity and quality which would optimise consumables in winemaking allowing for much more efficient use of inputs. Other important agritech solutions were predicted to be in planting, pruning and irrigation as well as in nutrient application, grape movements and logistics and harvesting. Each of these was predicted to potentially provide a 10 percent productivity improvement.

Forestry and Logging

This sector had few gains forecast in the growing phase because of its length (for example, 30 years in New Zealand for pinus radiata), but large potential gains in wood processing.[65] Almost 75 percent of productivity gains in the sector were predicted to come from data capture of logs at felling and in handling and the flow on effects into processing and optimising supply into markets for forest products. Other promising agritech solutions were projected to be the use of satellite technologies and remote sensing to monitor and manage forests, automation and robotics in harvesting and manufacturing and radio frequency identification and tracking to optimise the supply chain.

Poultry

Animal health benefits from remote sensing, decision support tools, nutrition management and marketing were believed to be the most promising agritech solutions. However, it was thought that the processing companies were likely to gain most, relative to contract growers on fixed margins.

Agritech Value for the Red Meat Processing and Fishing Sectors

Red Meat Processing

The gains to the red meat processing sector were low, relative to other areas at 15 percent. The largest gains were from better marketing with more information about product quality supplied to retailers connecting eating quality to provenance information. Carcase utilisation was another major contributor through reducing wastage of meat products and more precise boning and cutting. Other important gains were from process automation, for example, scanning and robotic cutting technologies.

Fishing

In contrast to meat processing, fishing was estimated to have the potential to gain up to 40 percent, with three quarters from real time data on fish stocks and locations. This would allow fish to be more quickly, cost effectively and accurately caught to match fishing quotas. Improved productivity from better navigation of vessels, due to better data on winds and currents and labour savings from automation and robotics also made a material contribution.

Estimating the Potential Value of Full Use of Agritech in New Zealand

Table 2 below shows the value of New Zealand's primary sector output in the year to the end of March 2018 in the first column. This totals almost $46.3 billion. The approach used was to fully apply the productivity gains estimated as possible from agritech, to New Zealand's 2018 base year statistics. As also discussed above, these percentage productivity gains were drawn from those used in the Australian Farm Institute study.[66] This shows that if these agritech solutions were applied in New Zealand, primary sector output could be 21 percent or $9.8 billion dollars higher than 2018 levels. This provides an indication of the significant value that could be achieved in the best case scenario of fully implementing these agritech solutions.

These productivity gains are indicative because they are drawn from literature, consultations, industry experts, benchmarking studies and workshops. They are inherently difficult to estimate due to many agritech systems and technologies only being in the early stages of development. In addition, the model used to map the economic flows in the Australian Farm Institute study used a model of the Australian economy. However, there will be similarities

TABLE 2: Increase in primary sector output if all agritech was fully adopted in New Zealand

Stats NZ national accounts industry production investment for year ended March 2018 (latest year)	New Zealand primary sector output $ million	Estimated primary sector output gain from full use of agritech	Potential extraoutput with all agritech applied $ million
Grains	$460	51%	$235
Cattle	$3,166	16%	$511
Sheep	$2,860	17%	$494
Wool	$548	18%	$97
Pigs	$161	5%	$8
Dairy products	$12,424	15%	$1,847
Poultry products	$212	24%	$51
Wine	$3,682	12%	$443
Horticulture & fruit growing	$4,677	40%	$1,852
Forestry and logging	$5,352	37%	$1,984
Meat & meat product manufacturing	$11,368	14%	$1,628
Fishing and aquaculture	$1,382	44%	$602
TOTAL	**$46,293**	**21%**	**$9,752**

Source: Statistics New Zealand see Appendix B: for more detail.

between the primary sectors of the Australian and New Zealand economies. Relative prices and production functions of the Australian and New Zealand primary sectors are likely to be comparable, particularly in sectors exposed to open international trade, and trading between the two countries, which covers most primary sector activities. This means that the difference between this estimate of the value of fully applying agritech in New Zealand, and one which used a New Zealand model and input output tables, may not be great. This view could be tested by estimating this value, using such a New Zealand general equilibrium model and input output tables. This could be considered as a further step in this analysis.

This estimate does not include New Zealand's Dairy Product Manufacturing output class. In the year to 31 March 2018, this reached a value of $20.6 billion and is a prominent part of New Zealand's economy. This is because this sector's productivity gains were not included in the Australian Farm Institute study because it was separable from the on-farm part of the value chain, which was the focus of that study. If it were included in the New Zealand value, it would be significantly higher. For example, if the Dairy Product Manufacturing sector had a level of productivity gain similar to that predicted by the Australian Farm Institute for the Meat and Meat Product Manufacturing sector, the total value of fully applying agritech in New Zealand would rise from $9.8 billion to $12.8 billion.

The Australian Farm Institute study's estimate for horticulture was restricted to leafy greens, brassicas and carrots. In Table 2 above, due to a lack of other estimates of the benefits of the full application of agritech to horticulture, its estimate has been applied to the value of all horticultural output. This is another aspect of the total estimate which could be improved by further investigation.

Methodology: Australian Farm Institute Model

The Australian Farm Institute estimates of the improved productivity from applying agritech in Australia were calculated using the Centre for International Economics Regions Food Processing Model (CIE RFP). Each projected effect of the use of 'decision agriculture' was applied to a base level of primary sector production. This allowed an estimate of the potential total output if all agritech was applied. The projected effects were assessed through a combination of academic and industry literature, consultation with the Rural Research and Development Corporation representatives and industry experts, benchmarking studies and industry workshops that were held as part of the Accelerating Precision Agriculture to Decision Agriculture programme.

The CIE RFP model uses Australian (Australian Bureau of Statistics input and output tables). It seeks to predict supply and demand flows between farms, processors and consumers across the value chain. Inputs consisted of 38 sectors and production functions mapped the links between inputs, substitutes and outputs for each sector. The CIE RFP model estimated the approximate breakdown of the Gross Value of Production (GVP) by assuming the various forecast practice changes were applied by primary sector participants and the projected productivity gains accrued. For example, a 10 percent productivity improvement was modelled for the viticultural sector from irrigation and nutrient application. The model then reallocated any savings in fertiliser to other sectors. This translated into a 1.3 percent increase in GVP in that sector and that effect flowed through the economic model to predict the impact on gross domestic product (GDP).[67]

Methodology: Data Sources

The New Zealand data applied to the model was sourced from Statistics New Zealand as follows:

- The grain value was estimated from 2018 agriculture output data 'Crop and seeds' (SG01NAC16P10A17).
- The first six primary sector categories came from the national-accounts-industry- production-investment-year-ended-march-2018. The ANZSIC06 New Zealand Standard Industrial Output Categories (NZSIOC) used were in order Cattle SG01NAC16P10A13, Sheep SG01NAC16P10A12, Wool SG01NAC16P10A11, Pigs SG01NAC16P10A14, Dairy products SG01NAC16P10A15 and Poultry products SG01NAC16P10A16.
- Wine value came from the 2013 Input Output table and was normalised to 2018, using the Growth rate between 2013 and March 2018 from the New Zealand Wine Production Stats from the New Zealand Winegrowers Association Annual Report 2019 Page 46.
- The last four primary sector categories came from InfoShare: Group: National Accounts - SNA 2008 – SNE Table: Series, GDP(P), Nominal, Actual, ANZSIC06 detailed industry groups (Annual-Mar). These included Horticulture & fruit growing SNE048AA, Forestry & logging SG01NAC04B01AA2, Meat & meat product manufacturing SG01NAC05B01CC11 & Fishing & aquaculture SG01NAC05B01AA31.
- Note dairy products do not include Dairy Product Manufacturing. ANZSIC06 detailed industry group level. Table reference: SNE048AA

Agritech Taxonomy

There is no single, agreed upon agritech taxonomy. For the purposes of this report, we have categorised agritech using pitchbook.com's agritech taxonomy.[68] Our characterisation of agritech includes farming inputs, production and harvest. It also includes some midstream applications such as food safety and traceability technology.

Plant Science

The modification of existing plants and organisms to improve plant health and yield, including plant breeding, development of novel traits, genetic modification/editing, and more.

Crop Protection and Input Management

The development of products and technologies that when applied, improve plant yield, including the development of synthetic and natural active ingredients, biologicals, formulations, seed treatments, and nutrient technologies to improve plant or soil health and reduce other inputs.

Precision Agriculture

The building of software suites, data management and analytics tools for improved farm management (including the measurement of crop inputs, soil, moisture, weather, inventory, etc.) typically within the realm of enterprise suites with user friendly mobile capabilities.

Agriculture Marketplace and Fintech

Online marketplaces for the trading, buying and selling of agricultural goods, as well as platforms for the management of related financial transactions and administration of business relationships.

Indoor Agriculture

The production of turnkey software and hardware systems designed for the cultivation of crops within buildings, often focused on either residential or commercial real estate markets, as well as related services and building of infrastructure.

Sensors and Smart Farm Equipment

The hardware and software systems specifically designed to monitor a range of conditions, most frequently within close proximity, plus equipment for farming, with integrative capabilities for whole platforms.

Imagery

The equipment, software and hardware systems plus actual manufacturing of drones and satellites for aerial monitoring.

Animal Technologies

The hardware and software systems specifically designed to enable management of livestock and other farm animals, with use cases from monitoring of health to more efficient harvesting of related resources. In addition, technologies aimed at improving formulation of animal feed and medicines are also included, ranging from veterinary drug applications to the entire nutritional spectrum.

Further Downstream

Further downstream there is a tech revolution happening in agricultural processing, transport, storage and distribution. Some of this innovation is agri specific and others are more vertical agnostic technology such as robotics and AI used in packing and fleet tracking for transport.

While the Pitchbook classification of agritech excludes downstream activity, it is worth noting there is significant innovation at the retail and consumer level. For example, there are several new business models including meal subscription services (for example, My Food Bag) and food delivery (Uber Eats).

References

1 Agritech in New Zealand, Industry Transformation Plan, New Zealand Government, 2020.

2 AgTech is the New Queen of Green, Techcrunch, Rob Leclerc & Melissa Tilney, April 2015.

3 Finistere Ventures & PitchBook Agtech Investment Review, September 2017.

4 Agritech in New Zealand, Industry Transformation Plan, New Zealand Government, 2020 (figures include forestry).

5 Situation and Outlook for Primary Industries, Ministry for Primary Industries, March 2020

6 Analysis by Ministry of Business, Innovation and Employment of Callaghan Innovation, New Zealand Trade and Enterprise and Agritech New Zealand databases, 2019.

7 TIN AgriTech Insights Report, Technology Investment Network, July 2020.

8 Callaghan Innovation database analysis, 2019.

9 Analysis of trade codes by MBIE using the method described by Coriolis, September 2014, New Zealand's Agritech Sector. The estimate relates only to agritech exports for pastoral farming and it should be treated with extreme caution due to the limitations of the analysis.

10 TIN AgriTech Insights Report, Technology Investment Network, July 2020.

11 Agritech in New Zealand, Industry Transformation Plan, New Zealand Government, 2020.

12 Global AgriTech Market by Type & Region Forecast to 2025, Infoholic Research, 2019.

13 Agri-FoodTech Investing Report, Year in Review, AgFunder 2019.

14 Innovation bearing fruit - Lessons from Israeli agritech, Deloitte, 2018.

15 Start-Up Nation Finder, https://finder.startupnationcentral.org/startups/search?list_1_action=and&list_1_tag=agtech.

16 https://www.government.nl/latest/news/2018/01/19/agricultural-exports-worth-nearly-%E2%82%AC92-billion-in-2017.

17 Netherlands 10 Year Agricultural Census, Eurostat, 2012.

18 CSO Trade Statistics, 2016.

19 The 'now normal' future. Food and fibre in a world emerging from Covid-19. Ian Proudfoot, KPMG New Zealand, April 2020.

20 How are agrifood tech startups responding to Covid-19?, AgFunder News, April 2020.

21 Impact of COVID-19 Survey, Callaghan Innovation, April 2020, shared via the Agritech New Zealand 'New initiatives to support early stage businesses in the current environment' webinar, April 2020.

22 Covid-19: Fruit industry facing hurdles with harvest due to restrictions, RNZ, 30 March 2020.

23 Statistics New Zealand, 2019.

24 Potential value of Agritech to New Zealand, Sapere, April 2020.

25 Perrett, E, Heath, R, Laurie, A & Darragh, L (2017), Accelerating precision agriculture to decision agriculture - analysis of the economic benefit and strategies for delivery of digital agriculture in Australia, Australian Farm Institute, Sydney.

26 Dela Rue, B. T., et al. (2019). "New Zealand dairy farmers preference investments in automation technology over decision-support technology."

27 Primary sector exports reach record highs. Beehive Press Release, September 2019.

28 Perrett, E, Heath, R, Laurie, A & Darragh, L (2017), Accelerating precision agriculture to decision agriculture - analysis of the economic benefit and strategies for delivery of digital agriculture in Australia, Australian Farm Institute, Sydney.

29 For example see https://www.agriculture.com/finding-the-value-in-ag-tech

30 As an example see Agronomy MDPI 'From Smart Farming towards Agriculture 5.0: A Review on Crop Data Management' Verónica Saiz-Rubio and Francisco Rovira-Más, February 2020.

31 See https://www.evineyardapp.com/blog/2018/08/23/why-to-implement-iot-in-the-vineyard/

32 Adoption of agritech solutions in New Zealand, Crannora Consulting, June 2020.

33 In its treatment of data analytics and decision support tools, the Australian Farm Institute report relied on a study by Darnell, R and Barry, S (2017) 'Precision to Decision - Current and future state of agricultural data in Australia', CSIRO and Skinner, A (2017), 'Precision to Decision – Big data technology report', Data to Decisions CRC.

34 Ibid.

35 In its treatment of trust and legal barriers, the Australian Farm Institute report relied on a study by Wiseman and Sanderston (2017), The legal dimensions of digital agriculture in Australia.

36 Kuehne, G, Llewlyn, R, Pannell, D, Wilkinson, R, Dolling, P, Ouzman, J, Ewing, M (2017) 'Predicting farmer uptake of new agricultural practices: A tool for research, extension and policy'.

37 Voight, S (2017) 'The economics of precision agriculture' and United States Department of Agriculture, A report summary from the Economic Research Service, David Schimmelpfennig, October 2016.

38 Dufty, N & Jackson T (2018) 'Information and communication technology use in Australian agriculture – A survey of broadacre, dairy and vegetable farms', ABARES research report 18.15, Canberra November.

39 Also see https://www.nationalgeographic.com/environment/future-of-food/food-future-precision-agriculture/

40 Thompson, N. M., et al. (2019). "Farmer perceptions of precision agriculture technology benefits." Journal of Agricultural and Applied Economics 51(1): 142-163.

41 Analysis by Ministry of Business, Innovation and Employment of Callaghan Innovation, New Zealand Trade and Enterprise and Agritech New Zealand databases, 2019.

42 The New Zealand Agritech Sector, Coriolis Research, September 2014.

43 Scoping Study on Australasian Agritech for UK Department for International Trade, KPMG, 2017.

44 The New Zealand Cooperative Economy, Cooperative Business New Zealand, Massey University and the University of Auckland, 2017.

45 Doing Business 2020, Ease of Doing Business World Rankings, World Bank, 2020.

46 Agritech in New Zealand, Industry Transformation Plan, New Zealand Government, 2020.

47 StatsNZ and Ministry of Business, Innovation and Employment R&D Survey, 2018. Figures include spending on forestry R&D.

48 https://www.mbie.govt.nz/business-and-employment/economic-development/industry-policy

49 Agribusiness Agenda 2017 The recipe for action, KPMG New Zealand, 2017.

50 See Statistics New Zealand site for further information on PPI. http://archive.stats.govt.nz/browse_for_stats/economic_indicators/prices_indexes/ppi-concepts-sources-methods-2015/conceptual-basis.aspx#measures

51 Bolt C and Chancellor W (2019) 'Drivers of agricultural productivity growth.'

52 For further information see https://www.crdc.com.au/precision-to-decision

53 Digital Technologies in Agriculture: adoption, value added and overview, Ivanov Igor, February 2018.

54 Precision Farming: Cheating Malthus with Digital Agriculture, Goldman Sachs, July 2016.

55 Benefits and costs of entry level precision agriculture technologies, Erick Haas & John Hanchar, Operations Managers Conference, 2017.

56 See https://precisionagriculture.org.nz/case-studies/precision-farming-paying-back/

57 Dela Rue, B. T., et al. (2019). "New Zealand dairy farmers preference investments in automation technology over decision-support technology."

58 See Productivity Commission, draft report Technological change and the future of work, 5 January 2020 available at https://www.productivity.govt.nz/assets/Documents/61d93edef6/DR5-Technology-adoption-by-firms.pdf

59 Dairy NZ, 5 June 2019 submission to the Productivity Commission on technological change and the future of work.

60 Perrett, E, Heath, R, Laurie, A & Darragh, L (2017), Accelerating precision agriculture to decision agriculture - analysis of the economic benefit and strategies for delivery of digital agriculture in Australia, Australian Farm Institute, Sydney, Page 146.

61 Ibid, Page 24.

62 Ibid, Page 144.

63 New Zealand domestic vegetable production: the growing story, 2017, hortnz.co.nz also see New Zealand's Food Waste: Estimating the Tonnes, Value, Calories and Resources Wasted, February 2016, Christian John Reynolds, Miranda Mirosa and Brent Clothier, Page 9 available at https://www.mdpi.com/2077-0472/6/1/9/pdf

64 Reidy, M. (2017, March 23). Innovation series: Zespri strategy includes robots and anti-counterfeit app.

65 A good report setting out agritech options in forestry is 'Precision forestry: A revolution in the woods, Harsh Choudhry and Glen O'Kelly, McKinsey & Company, June 2018.

66 Perrett, E, Heath, R, Laurie, A & Darragh, L (2017), Accelerating precision agriculture to decision agriculture - analysis of the economic benefit and strategies for delivery of digital agriculture in Australia, Australian Farm Institute, Sydney.

67 For more information see Perrett, E, Heath, R, Laurie, A & Darragh, L (2017), Accelerating precision agriculture to decision agriculture - analysis of the economic benefit and strategies for delivery of digital agriculture in Australia, Australian Farm Institute, Sydney, Appendix 1, Page 97.

68 Finistere Ventures & PitchBook Agtech Investment Review, September 2017.

Agritech NEW ZEALAND

e info@agritechnz.org.nz
w agritechnz.org.nz
w digitalnation.nz
t @agritech_nz