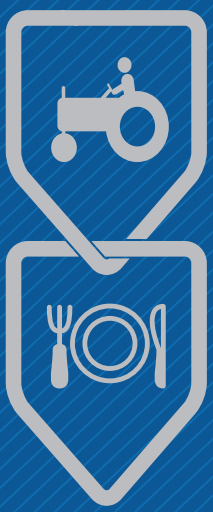
FARM IQ® PROGRAMME INSIGHTS

THE YEAR 7 REPORT ON FARM IQ FOR FARMERS AND INTERESTED PARTIES

FARM IQ AIMED TO CREATE SOMETHING THAT DIDN'T EXIST:

A DEMAND-DRIVEN, INTEGRATED VALUE CHAIN FOR NEW ZEALAND RED MEAT.

FARM IQ IS BRINGING FARMERS AND CONSUMERS TOGETHER



FARMERS

Farmers understand how to produce animals that meet consumer preferences and receive payments based on meat quality.

CONSUMERS

Consumers are offered premium-branded red meat that consistently meets their eating quality preferences.

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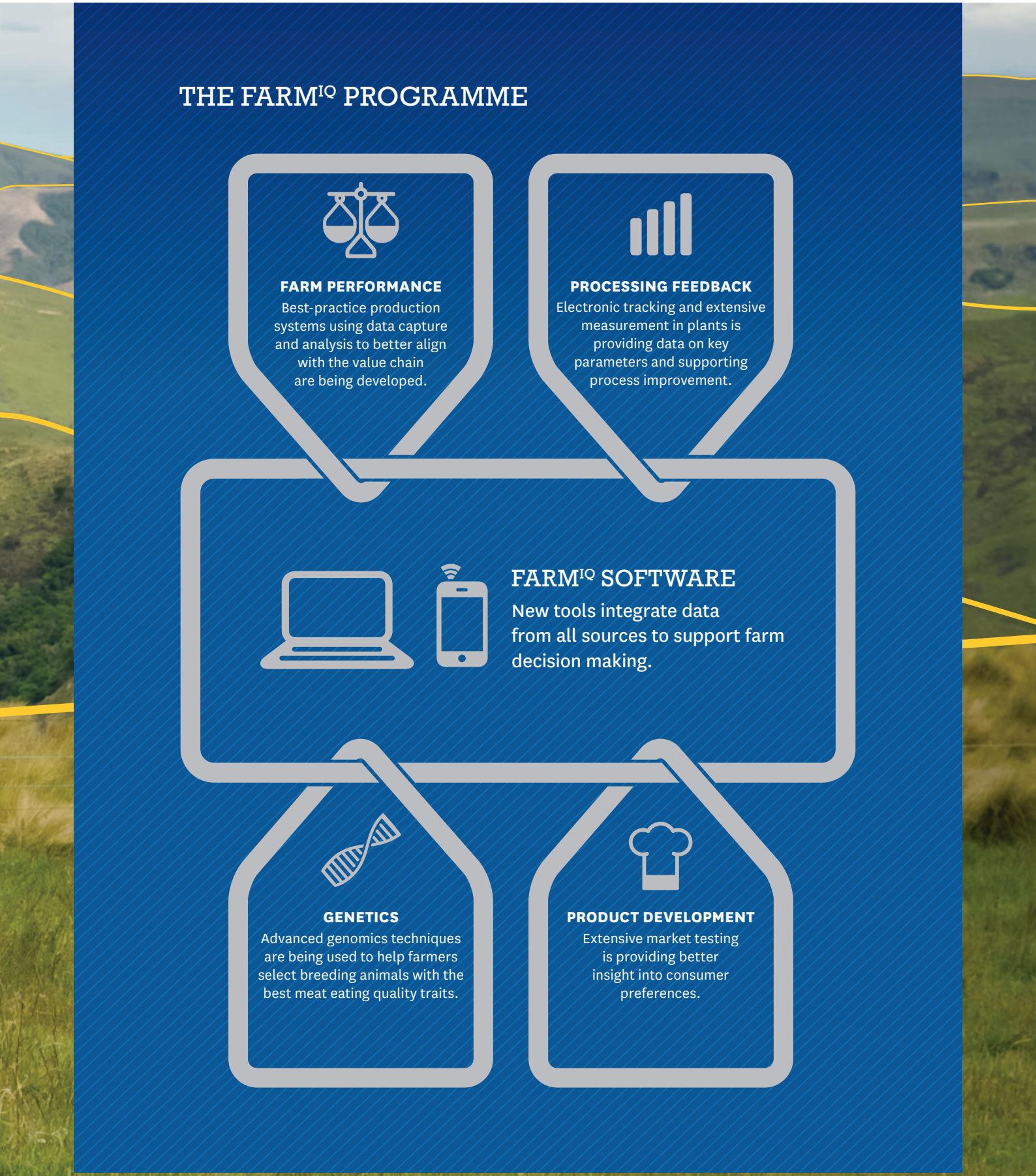
THE FARM[IQ] PROGRAMME



PROGRAMME OUTCOMES (END OF YEAR 7)

OVERALL

Value being created is estimated at **$1.2b** by 2025 by NZIER

Likely cost-benefit ratio in 2025 for the value created above is estimated to **exceed** 20 with ratios of between 3 and 5 being an accepted international benchmark of success.

PRODUCT DEVELOPMENT

Premium value-add sales of **$260m** since the start of the programme

Market insight has been gained from **20,000** consumers in 12 key markets

BeefEQ – a linked-up value chain delivering **$3m** in premiums to farmers

Lamb leg added-value products worth **2.75** times the commodity equivalent

Processing measurement systems implemented to **manage** beef eating quality for BeefEQ

PROCESSING

Processing measures established to **guarantee** eating quality for lamb

Electronic ID technology installed to **track** individual sheep, beef and deer carcases to the boning room

SOFTWARE DEVELOPMENT

Company established with good **commercial** future and committed to ongoing product development.

Farm management software in use by **12%** of the sheep and beef industry (1440 farmers), offering recording, analysis and reporting tools

GENETICS

Technology platform established for **cost-effective** genetic selection tools for sheep and deer

Sheep breeding values for eating quality traits **exceeding** programme target of 2%pa

FARM PRODUCTIVITY

Productivity (carcase weight per ha) of the 11 IQ Farms using new-generation measuring and monitoring tools has been lifted by an average of **6%**pa over the programme period.

FARM IQ®

OVERVIEW

TRANSFORMING THE VALUE CHAIN

Now is the time for the Farm[IQ] Primary Growth Partnership (PGP) programme to take stock and reflect on what has been achieved over the past seven years.

We have run an innovation programme that has taken the industry well beyond business as usual, as is required of PGPs, and as a result no outcome was certain.

The interesting questions at this point are:

How did the programme perform against the vision and what value has been created? | **What outcomes and work will continue and have a future life?** | **What has been learned?**

VALUE CREATED

We identified that achieving the vision would mean listening to the meat consumer to understand what they want (and will pay more for), then working together across the supply chain to ensure their expectations are being consistently met. The five workstreams have systematically worked through all the components that would achieve this vision.

Now, new premium meat product ranges are being offered in a range of markets, but more importantly there is a platform for continuing to develop new products that will consistently meet consumers' quality expectations and earn premium returns for farmers and the industry. We are confident in the robustness of the development work because it has been underpinned by good science at every step. Also, marketers better understand what consumers want to know.

Silver Fern Farms, which ran the Product Development workstream, reported a 31% increase in value-add sales in their 2016 Annual Report, and $3 million in premium returns being paid to farmers supplying for the BeefEQ programme.

Farmers, for their part, have access to several new tools as part of the Farm[IQ] software that enable them to get a better insight into what works in their farm situation and what doesn't. They are also able to get more precise feedback from their processor about carcase performance and to drill down to see what on-farm decisions have had an influence. Measuring to manage has become a by-word for forward-looking farmers. They also have access to tools that help them run their day-to-day operation and cover compliance requirements. Importantly, a new company has been established that is offering this software on a commercial basis and is committed to ongoing development.

Good progress has also been made in building tools for agribusinesses, which are able to use the software platform to achieve their own objectives in working with farmers.

Sheep genetics suppliers now have access to cost-effective measures of an animal's potential to produce meat of high quality and productivity much earlier in its life. This is a powerful tool in selecting animals for breeding.

An economic analysis by the New Zealand Institute of Economic Research (NZIER) estimated at the outset that the Farm[IQ] Primary Growth Partnership programme would grow NZ's GDP by an additional $1.2 billion a year by 2025.

The programme proceeded against a backdrop of changes in the operating environment – some of which fitted our assumptions and plans – and some that did not. The programme kicked off at the end of the Global Financial Crisis, for example, when there was a great deal of volatility in commodity markets and customers were reluctant to take longer term pricing positions, so it was challenging to sell premium products or create long-term contracts.

The original economic analysis was based on an assumption that the red meat sector would shrink during the life of the programme, but in fact it has grown slowly. Also, in a follow-up analysis done in May 2017 NZIER commented that the value of business-as-usual – using technology already available at the time, was significantly under-estimated in the original report. The analysts also felt that take-up rates for tools were overly optimistic.

The analysts noted that most of the benefits will accrue between 2017 and 2025. Against this background, the follow-up report assessed that Farm[IQ] has been successful. Allowing for the expected shrinkage that didn't occur, the programme is on target to generate economic gain of $0.6 billion a year by 2025. It is very likely to exceed 20, with ratios of between 3 and 5 being the accepted international benchmark for this kind of programme.

CONTINUING RESEARCH

The Farm[IQ] programme encompassed a large number of research and development projects. Some of these have come to fruition during the seven years of the programme. By contrast, some of the projects have proven to be a chapter – a much-needed chapter – in a process that will take much longer.

The genomics work, while hugely valuable, is being picked up by others as a stepping stone towards newer and more powerful technologies and a range of uses. For example, Beef and Lamb Genetics is trialling using upgraded SNPchips for productivity traits and the deer industry is making good use of Genotyping by Sequencing.

This is also the case for the in-plant meat quality measurement work. One meat quality measurement technology that was identified as showing some promise was hyper-spectral analysis and the Ministry for Business, Innovation and Employment (MBIE) is funding further development work.

LEARNINGS

Some projects have given us answers – which have told us not to proceed further – and that is highly valuable too. In other words, every project has been useful even if it did not provide us with the answer we might have hoped for – now we know!

One project in this regard is the Lamb Eating Quality work – which revealed that rather than on-farm management, the main influences on the consumer eating experience lie beyond the farmgate, such ageing and giving better guidance on cooking. However, while breeders focus strongly on improvement of other traits such as growth rates, disease resistance and yield, use of the SNP chip developed by the FarmIQ Genetics workstream will ensure that the current high eating quality of lamb is maintained. A remaining challenge is while the sheepmeat industry has new genomics tools, there is no direct mechanism (yet) for a farmer using them to earn premium returns for doing so.

Another example is the on-farm measuring and monitoring work which did not result in a set of management recipes for good production outcomes, as we thought it might, but rather showed the value of good tools that the farmer can use to tailor their management to their own farm situation.

The important thing has been the opportunity to get this enormous amount of work done, and we want to acknowledge the partners who have taken such care to nurture the programme's success every step of the way. This has required a delicate balancing of priorities from a range of different parties – which is no mean achievement.

Another notable aspect of this programme has been the wide range of people we have worked with. We are very grateful for the respectful relationships we have had with many individuals, organisations and businesses over the past seven years. This was crucial as we all explored what was possible.

Alison Paterson and Collier Isaacs

PROGRAMME HIGHLIGHTS OF THE 2016/2017 YEAR

In May 2017 the commercial entity FarmIQ Systems Ltd. took on its first additional shareholder. Veterinary Enterprises Limited operate in 25 locations across NZ and use the FarmIQ software for grazing management and livestock advisory services. Their purchase broadens the ownership of FarmIQ and supports the company's position as the central information hub for the pastoral sector.

The FarmIQ software now supports more than 5.9 million stock units being run on 1.4million effective hectares.

In April 2017 Silver Fern Farms released the findings of the Lamb Eating Quality project that had been undertaken through the programme. More than 3,200 consumer taste tests were conducted on over 23,000 samples of lamb, both in New Zealand and the USA. This work showed the eating quality of New Zealand lamb is generally good and the results will be used to ensure that this standard is maintained as farmers breed for increased productivity traits.

FarmIQ's software development capability was called on to help run a pilot for the Sri Lankan government, which not only assisted trade relations but also demonstrated the adaptability of the FarmIQ software platform.

The use of Genotyping by Sequencing technology is expanding rapidly, following proof of concept work in the early part of the FarmIQ programme. It was taken forward with other funding and now sample numbers are more than doubling each year. The New Zealand deer industry switched entirely to GBS this past year and some 38,000 deer samples have been genotyped.

PRODUCT DEVELOPMENT

DELIVERING CONSISTENTLY GOOD MEAT QUALITY

Over the 7 years of the Farm[IQ] programme the Insights Product Development workstream has tested and prototyped approaches to developing value-added opportunities in global markets for red meat – with pleasing results.

From year 1 we have been determined to develop value-added offerings in the consumer and food service sectors in key, high-value markets. This has been backed by consumer market research, the development of skills capability, development of a fully-integrated Eating Quality programme and the development of effective marketing approaches. To deliver on a market-led strategy we established a new product development process and joint business plans with key customers. Creating new consumer value through product differentiation by selecting and marketing beef and lamb products that have consistently superior eating quality is now a critical part of the Silver Fern Farms Plate to Pasture strategy.

The result has been $260 million in premium value-add sales since the start of the programme.

BEEF AND LAMB RESEARCH

Consumer research identified a clear need to eliminate the inconsistent product quality inherent in beef and also a growing high-value consumer segment for natural grass-fed product. Therefore the initial focus for new product development was premium grass-fed beef. The resulting development of BeefEQ, the Silver Fern Farms Reserve Beef brand and a value-added product range for food service and retail customers is a commercial highlight.

Importantly, BeefEQ has enabled farmers to receive more value from the market for providing customers with a product that delivers on its promise of consistently high-quality beef. Also, the information passed back to farmers via electronic ID (EID) technology and through the BeefEQ grading process has completed the feedback loop that underpins an integrated value chain. This has enabled farmers to receive timely feedback on their livestock performance so they can adjust on-farm management.

The BeefEQ Master Grade System was developed to determine which product is suitable for the Silver Fern Farms Reserve Beef and retail beef ranges. It was critical this was robust, science-based and could be commercialised. In 2012/3, following a consumer segmentation process, consumer taste tests were carried out in New Zealand and the United States on 96,000 beef samples, in the world's largest taste test of grass-fed beef. This research was funded through Silver Fern Farms, the Farm[IQ] Primary Growth Partnership programme and the State of Texas.

Approximately 170,000 animals are now assessed by our Master Graders each year. The Silver Fern Farms Premier Selection Reserve Beef range and EQ Master Grade on Silver Fern Farms beef retail packs are now well recognised brands and marks of quality. These value-added ranges have experienced sustained growth off the back of this consumer acceptance. Significant premiums are being achieved in the market over and above standard cuts, and these are being shared with suppliers through Backbone supply contracts for animals that achieve the Beef EQ Master Grade. As a result of the PGP, over $3 million was paid in premiums to farmers over the past 12 months.

Keys to success have been the development of a compelling consumer brand story, high-quality product, market segmentation and building partnerships with companies that can effectively market value-added products.

Partnerships have been crucial: both in the New Zealand market where approaches have been trialled and in key export markets. In the United States Marx Foods have been with us through this development process: researching consumers, road-testing new products and testing marketing approaches, and their customers are showing strong support for the Silver Fern Farms Angus beef range.

We have adapted our approaches to suit the needs of other key markets. This has been particularly successful in the Chinese Food Service market, which is now our largest market for Reserve beef with high-end restaurant suppliers Angliss and Bester Foods taking the product in frozen form at chilled prices. 2015/16 saw 31% growth in branded/value add sales of food service and branded retail products in New Zealand and overseas.

The Silver Fern Farms retail ranges for lamb and venison as well as beef products continue to perform and grow in appeal with consumers in key markets domestically and latterly in Germany. In year 1 we were determined to test our Silver Fern Farms branded consumer strategy in Europe. We started with a retail trial in the United Kingdom with our partner Tesco and undertook consumer research in Germany with a view to launching in this high-value, red meat market. In 2016 we launched our retail range into 1,000 Edeka and Rewe supermarkets in Germany. Launching a brand into a large and new international retail market like this is exciting but also requires ongoing commitment and investment.

The next challenge was to identify an Eating Quality system for lamb. As a product lamb does not have natural widespread quality variation (due to the younger age of the animals). In 2015 preparation commenced for the Reserve Lamb Pilot, the largest consumer taste panel research for lamb done in New Zealand to date. The researchers tested 23,000 samples of lamb with over 3,200 consumer taste tests in New Zealand and the USA. It was undertaken by Texas Tech University and the University of Otago and international meat quality experts and followed the same, robust science-based process used to develop BeefEQ.

The results confirmed earlier research that consumers view New Zealand lamb as a consistently high-quality eating product. A report, *Lamb Eating Quality: The commercial application of findings from Silver Fern Farms' consumer and on-farm research into the Eating Quality of lamb*, was released in April 2017.

The research showed lamb eating quality is most affected by taking steps to: select the right cut, correctly age the meat, and correctly match the cut to the cooking method. Earlier research also highlighted that a story can influence consumer perceptions of eating quality by creating an appetite appeal effect.

To determine genuine consumer-led demand for value-added offerings, Silver Fern Farms has used a consistent "plate-to-pasture" approach:

- Research and market-test consumer needs and wants
- Work with key customers in targeted global markets
- Test and develop new processing technology and methods
- Work with farmer suppliers to test and measure new on-farm practices using the Farm^{IQ} farm software
- Develop new animal improvement genetic tools (such as SNP chips),
- And, finally, assess impacts of on-farm management methods.

Grant Howie with consumer packs of lamb.

LEARNINGS

As is the case with any research and development – not all projects have been equally successful or relevant.

In 2016 Silver Fern Farms made the decision to pass on our involvement with the NZMerino Company in SILERE alpine origin merino branded product. This was a Food Service range developed to appeal to chefs in the USA, China and the Middle East. After 5 years of development, it was timely for both partners to consider its next phase. Silver Fern Farms believed we would be better to focus on our own branded range of natural, grass-fed products that have the ability to more easily cross-promote each other and were seeing sustained, year-round growth.

Our retail range in China tested e-commerce as a sales channel in 2014. Through a customer in China we ran a trial with a Shanghai-based TV shopping channel and established online shops on leading China e-commerce platforms. There was useful learning around the ability for e-commerce to create sustained awareness and generate repeat sales. Subsequent to this trial, Shanghai-based Food company Shanghai Maling became a 50:50 investor in Silver Fern Farms, and this opened up significant opportunity to access the China market at scale. We are currently redesigning our product range to have wider appeal to target consumers who we can leverage through our partner Shanghai-Maling's extensive retail network.

Our brand proposition has been tested over the course of the programme, and we believe we have a clear proposition that has strong appeal with consumers and customers across our global markets. It is built on the demand for natural, grass-fed, red meat that has a strong New Zealand provenance. "100% Made of New Zealand" has good brand appeal which we leverage through our retail and consumer ranges.

An example where the brand has been a vehicle to successfully capture attention at the top end of the market is the Middle East. With our branded Food Service ranges we have been able to follow developments in the market to meet a growing appetite for chilled, branded, prime-cut products. We leveraged the learnings from our earlier market launches into the USA with Marx Foods and adapted them to ensure that our partners in the Middle East have capability and support to deliver our branded ranges to chefs in the Food Service sector.

Though it seems obvious, we understand that a one-size-fits-all sales and marketing approach across all our global markets cannot be pursued with success. Market segmentation is important. Understanding global consumer trends in order to keep marketing campaigns and product offerings relevant is crucial. We leverage consumers' rational reasons to buy, for example with our science-backed Eating Quality Master Grade. And we leverage their emotive reasons to buy, for example through brand story-telling tailored to consumers in each market.

This investment has successfully embedded the right culture and capability of product development, marketing and delivery into Silver Fern Farms to ensure the continued pursuit of value-added opportunities for red meat.

"Over $3.5 million was paid in premiums to farmers over the past 12 months."

PROCESSING FEEDBACK

by Grant Pearson

DEVELOPING BETTER PROCESSING SYSTEMS

The Farm^{IQ} Processing workstream completed its work during Year 4. The workstream covered traceability, yield measurement, quality measurement, process optimisation and quality improvement.

The aim of the traceability work was to develop electronic tracking and measurement in processing plants. There were plenty of challenges getting new technologies to work well, but some good progress was made in developing systems that collect information for suppliers and help improve meat yield and quality. The electronic ID (EID) scanning systems for cattle, deer and sheep are all working well. We worked closely with the equipment manufacturers to develop improved panel readers and get high read rates by dealing with electrical noise and interference. We now have radiofrequency ID (RFID) tags in the carcase hooks to track carcases through to boning rooms and use this to collect data on each animal. Also, we worked with Oritain Ltd to develop a biochemical traceback system to prove product country origin authenticity.

Our main effort on yield measurement was installing Xray grading systems in all sheep plants and getting them running reliably to predict primal weights. Equipment providers are continuing to move to the next generation of Xray equipment (DEXA), that will give meat, fat and bone proportions for each carcase. Since project work ended, further development work has been done in Australia for both beef and lamb. We also have a primal yield measurement system in place for all our venison plants that is based on the reduction of weight along the boning rail as each carcase is boned.

Meat quality measurement has proved challenging, with none of the technologies tried proving suitable for highspeed online measurement. We decided to cease work on this project and keep a watching brief on developments in other countries so we can pick up promising new technologies when they are commercialised.

We learnt a lot about meat quality during the project and fine-tuned many of our systems to optimise eating quality of beef, lamb and venison. The BeefEQ programme developed out of this work, with Silver Fern Farms Reserve beef products launched in market, giving increased returns to suppliers. We also got encouraging results from work on high-pressure processing of hot-boned beef to improve tenderness, and rapid freezing technologies to capture the best quality attributes without the downside of normal, slow freezing. We are working with Lincoln University to publish a series of papers on the high-pressure processing technology, the first of which has been published by *Meat Science*, the leading international meat science journal.

The work done with AgResearch on chilled lamb microbiology has been used to deliver outcomes such as updating the best-practice guide for chilled lamb production made available to the New Zealand industry. Further work in the field is progressing with funding from Meat Industry Association (MIA) Innovation. Progress on working with UK supermarkets to accept lamb from spray-chilled carcasses has had positive impacts for New Zealand meat companies, with about 2% yield loss prevented through the spray-chilling process. Exploratory work on meat purge by Carne Technologies is continuing with funding by MIA Innovation, with potential quality and yield gain benefits.

An experimental beef boning station at Finegand using RFID tags embedded in plastic trays for yield measurement.

FARMER INSIGHTS

FARMING WITH FACTS

Wairarapa farmer Grant McGhie is using the Farm[IQ] software to give him better information about what's happening on a busy farm.

Grant has managed 1500ha Wairio Station in Wairarapa for the past 32 years. It's mainly river flats that are prone to flooding a few times a year, so the focus is on finishing. He works with 5 fulltime staff and a part-time person to finish 3000 own-bred lambs each year as well as up to 17,000 that are brought in, along with producing around 1200 prime steers and grazing 500 dairy replacements.

Grant brings a very practical approach to farming – and the Farm[IQ] software is part of the toolkit. "It is a great tool," he says. "I am not really a computer man but it's so easy and so useful.

"We use it daily. Everything we do we enter. The farm staff have phones so they record what they have done and then get on with the next job. The information is available immediately. If the stock manager has weighed or drenched a mob, I can see that straight away. It's not sitting on a piece of paper or in a notebook. It means everything to do with the farm is all in one spot."

Recently an auditor from a European supermarket arrived with little warning. "He grilled me for four hours... about everything we do on the farm. He asked me where we bought one group of animals and to show evidence of when they were killed. He was looking for traceability. Everything he wanted to know I could show him using the Farm[IQ] software."

Grant ran a test recently when a mob of 400 two-year-old steers arrived looking like they needed a drench – though the accompanying paperwork said they'd had one. It was easy enough to do, he explains. They drenched some of the mob and recorded that against their EID tags, then they ran them all together and six weeks later brought them in for weighing. A Farm[IQ] report showed that drenched steers were growing at an average of 1500g per day and undrenched ones just 500g – a kilo less per day on the same feed. Grant has previously used the software to run similar tests of copper and mineral supplements.

Grant's using Farm[IQ] carcase performance reporting to try to get more of the beef cattle into premium grades. The BeefEQ report links carcase results with on-farm management factors such as breed, supplier or feed. He is particularly interested in getting more consistent marbling. "It gives you better information. You can compare groups and run on-farm tests to look into anything you want to know."

Owners of the grazing dairy stock can get log-in access to view monthly weighings and any animal health treatments while they are on Wairio. Also, the on-the-go recording is feeding in to a realtime stock reconciliation, which makes monthly reporting easy and gives Grant figures to plug into Farmax for detailed feed budgeting.

On the land side Grant's getting a lot of value from the interactive farm map for planning and also showing contractors around, and his team are recording everything that happens in paddocks.

"We are recording everything as we go – what seed, the rate, what fertiliser and chemicals are going on and what supplements are taken off, as well as pasture covers."

MAKING FARM RECORDING SIMPLE AND ENJOYABLE

Owaka farmer Penny White is feeling a lot more confident about the next farm audit now that she’s organised recording with the Farm[IQ] software.

It has turned something that was always a hassle into something simple – and even fun, she says. Penny does the bookwork for Hina Hina farm on the coast close to Jack’s Bay, while her husband Peter does the day-to-day management. They run 2500 stock units of sheep and beef for breeding and finishing, on 253 hectares across two blocks about 10 minutes apart.

In March 2017 Penny started using the Farm[IQ] Starter Pack, which is designed to cover farm assurance requirements and more. It’s helping them work towards their overall goal of running the farm more efficiently, she says.

Penny has an off-farm job, but being able to access the farm information from anywhere using log-in access means she can make the most of any down-time. “I help Peter keep track of what’s happening. I make sure the paperwork gets done, and with the Farm[IQ] software you don’t have to be home on the computer.”

It has made the recording easy and enjoyable. “We needed a motivation to keep track of everything for farm accreditation. Keeping a paper diary wasn’t working for us, and in the past we would do a mad rush just before an audit to get everything up to date. Now I use the phone app to record as we go, and we will be ready for an audit. I like doing it too – it makes it more interesting.”

She’s impressed with the interactive farm map. “It’s a proper, correct, up-to-date map. You cover several things with it – paddock names, areas and hazards for example. It really helps with communication. We went through and sorted all the paddock names and that’s been really helpful. I’m planning to give a copy to the digger driver, spray contractor and the transport company who put on the super.”

Because she likes working with the Farm[IQ] software, Penny says it’s inspiring her to do more. “I like the health and safety aspect – it’s good and simple. I needed to start working on that. The software gave me motivation and the push to get that sorted. I’ve made a start with recording things like near misses and hazards. A crossing on the farm was washed out recently. It was easy to put that on the map – and then I can take it off later when that’s been fixed.”

Also, Peter is planting up riparian areas around wetlands with natives, and Penny has marked them up on the map.

She believes they’re building up a valuable historical record too. “The long-term plan is to keep track of what’s being done on the farm – for example the super and chemicals going on each paddock. In future, if our kids are on the farm and want to look back, they can see how the farm is run and what has been done.”

“Technology is here – embrace it and make it work for you.”

GENETICS

POWERFUL NEW BREEDING TOOLS

This workstream set out to produce genetic and genomic breeding value predictions for growth, yield and meat quality in terminal breed sheep sires.

We undertook the following phases:

- High-density SNP chip development
- Identify and measure eating quality and carcase yield traits in progeny of terminal sires. Indicators of eating quality- meat tenderness, pH, marbling, colour and colour stability
- Genotyping individuals and prediction equation development.
- Beta test results in commercial terminal sire breeding flocks to ensure the system is accurate, practical and cost-effective.

Advanced genomic techniques together with in-depth meat quality and yield trait collection were utilised to establish a genomic tool that now allows the terminal sire breeders to predict which terminal sire rams are likely to produce offspring with better quality meat. This was achieved through the development of the high-density genotyping chip which enabled Farm^{IQ} to identify the genetics behind meat yield and quality for the first time.

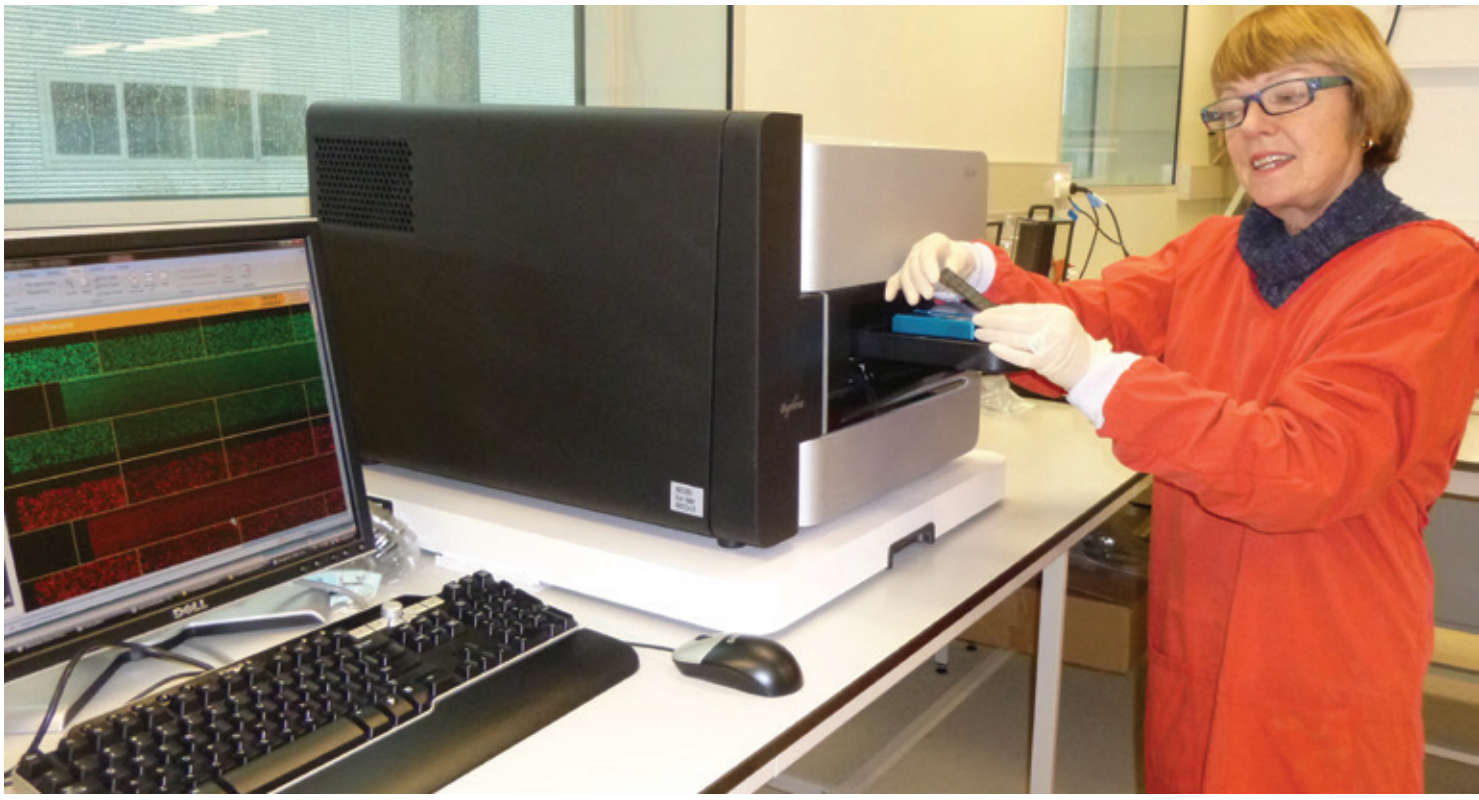
More than 18,000 animals were measured and genotyped. The initial phase utilised progeny from terminal sires from the Focus Genetics and AgResearch progeny tests, which in turn enabled the project to deliver to the terminal sire breeding industry. During the beta testing phase, the project team worked with 11 flocks that produce Texel terminal sires or composite-type genetics derived from Suffolk, Texel and Poll Dorset breeds.

The project is now ensuring implementation into the industry via a low-density, low-cost version of the SNP chip, allowing for earlier selection of terminal sire rams. This “Genomics Solutions” (GS) chip will enable breeding values to be delivered prior to weaning, dependant on when DNA sampling has occurred. This is an early selection tool for meat quality, taking selection from a two-stage process to one stage. It can be used for both terminal and maternal traits.

While the focus of this work has been on meat quality, the same low-density chip can be used for other traits sheep breeders are selecting on. This chip also contains more than 900 specific parentage SNPs, including the previous New Zealand industry parentage SNPs.

SOUTH ISLAND GENOMICS CALIBRATION (SIGC)

Industry implementation requires continued testing in the training flock (SIGC) to maintain accuracy and validation of the meat quality trait measurements. The training flock includes sheep from Focus



Researcher Di Hyndman with the Illumina iScan used for the HD chip development.

by Shannon Clarke, shannon.clarke@agresearch.co.nz

Genetics (FocusPrime and Texel), and Kelso and Suftex breeders, who are working with AgResearch and Beef + Lamb New Zealand Genetics to ensure the low-density test for meat quality and other production traits is implemented in the industry.

The partnership for the SIGC is Landcorp, AgResearch, Beef+Lamb Genetics, Focus Genetics, Suftex (which includes Kelso and Anzco) and Suffolk, with Silver Fern Farms assistance with the slaughter. This is a direct follow-on from the Farm^{IQ} workstream implementing the results in industry through maintaining and improving the genomic predictions for meat quality and carcass composition traits in terminal sire breeds. It is also linked to the Beef + Lamb Central Progeny Test by the use of link sires.

The new chip, likely to be known as the Genomics Solutions (GS) ovine chip, is fully backwards-compatible with all previous ovine SNP chips, and its closest cousin is the previous 15K chip that has been used for the past two years. The chip is still being validated but offers all the single gene tests that were previously available on the 15K chip (in New Zealand the GDF8, GDF9 and BCO2 tests were commonly reported) plus also some additional single gene tests including one for scrapie. The GS chip will also be used by Beef + Lamb Genetics and the follow-on to Farm^{IQ} terminal sire breeders for estimating breeding values.

HIGH-DENSITY SNP CHIP

The high-density Ovine genotyping array (the HD SNP chip), which was developed in conjunction with the International Sheep Genomics Consortium, has not only enabled this workstream to deliver DNA-based meat quality breeding values to industry, it has also had far-reaching benefits both nationally and internationally. As part of the Farm^{IQ} work more than 100 New Zealand genomes were contributed to this resource in the SNP discovery phase.

Within New Zealand, key groups now using the chip include Ovita and Beef + Lamb NZ Genetics whose primary focus has been on maternal traits and for greenhouse gas research both the Pastoral Greenhouse Gas Research Consortium (PGGRC) and New Zealand Agricultural Greenhouse Gas Research Centre (NZAGGRC) have utilised this genomic tool.

Perhaps more importantly, a key aspect of this chip is the ability to impute to the whole-genome-sequence equivalent (that is, predict all DNA variants in an individual even those not genotyped) when combined with the 1000 sheep genome International Sheep Genomics Consortium initiative in which AgResearch is a partner.

GENOTYPING BY SEQUENCING (GBS)

This research started because when the workstream commenced we had identified two competing options: GBS or a high-density (HD) SNP chip – which would enable genotyping at a higher density than the existing 50K chip. At the decision point, GBS was felt to be too risky and we opted to develop the HD chip.

However, initial research was done to the proof-of-concept stage on GBS for cattle, sheep and especially deer. This showed it to be a very useful and potentially lower cost alternative for medium-density genotyping. This was a consideration for Farm^{IQ} as the programme encompassed all three livestock species, and it was clear that an HD chip would never be viable in deer. Low-level funding continued on GBS for ruminants with the technology being transferred to a separate MBIE-funded project breeding ryegrass and clover and internal AgResearch funding.

More recently, this work has begun to expand rapidly with sample numbers more than doubling each year. In the latest year more than 70,000 samples have been genotyped via GBS with a total of more than 120,000 from over 40 species completed to date.

This past year the deer industry switched entirely to GBS and some 38,000 deer samples have been genotyped with this technology. In one year they have now matched what the sheep industry via Beef + Lamb investment has undertaken over the past eight years and their entire stag breeding industry is switching to genomic selection. This will assist genetic improvement in all traits, not merely eating quality.

At this time the sheep and cattle industries, with their larger international infrastructure, are still finding SNP chips to be cost-competitive. However, the new technology will have a very wide impact particularly through being used to genotype New Zealand native species for their long-term management. To date the technology has been used in kakapo, black robin, fur seal, koura and white chinned petrel, to list but a few species.

SOFTWARE DEVELOPMENT

BUILDING SOFTWARE THAT WORKS FOR FARMERS

As we have reached the final year of the project it is appropriate to look back at the original objectives for this workstream and look at what's been achieved and what's changed.

At the outset the intention was to build an information system for a farm that would bring relevant information from along the value chain and be a decision support tool for the farmer and parties they work with.

To achieve this there have been more than 12 major software releases over the past 7 years.

Year 1 saw the establishment of groups to advise on the requirements for what would be built: the core advisory team, the farmer-based Technical Development Group and the Systems and Technical Advisory Group, along with a business analyst from Landcorp Farming. A pilot system with limited functionality was made available to interested farmers, and various technologies were deployed for testing on farms.

By the end of Year 2 the pilot software had been outgrown by many of the users; key development partners had been selected and the two-year build of the core functionality of the Farm^{IQ} software had started. The original brief was for over 1200 high-level user stories (each representing a user need that would be addressed through the software). A quote from that time highlights the complexities that were anticipated: "This is no ordinary stock or inventory database. Our stock moves around paddocks; they are of different sexes; they die; they have singles, twins, triplets or are dry; they grow at different rates; suffer from different diseases... and are managed by farmers with different ideas. You get the picture!"

Year 3 saw the release of the initial Farm^{IQ} farm management software, replacing the pilot. The initial core functions included a GPS map, basic land recording, stock management by EID, NAIT integration, a mobile app to allow capture of weigh files from TruTest and Gallagher, and integration with Silver Fern Farms carcass data.

Year 4 saw a major upswing in development with 4 major releases and a fundamental change from software that required the use of EID tags to one that could work on EID, tally or both; the ability to create and monitor Key Performance Indicators (KPI), enhanced data capture and reporting and the ability to break the software into specific packs to both simplify the interface and allow a farmer to select the parts that best suited their needs.

Year 5 saw the commercial launch of the software and recognition from the Wellington business community winning the Discovering Gold category for Research and Development projects. The software itself continued to evolve with three releases and major enhancements to the mobile apps, a range of planning tools, the ability to store documents and integration with CashManager Rural and Farmax.

Year 6 saw the addition of two compliance modules to address Health & Safety and Environmental Planning. Also we made our first forayinto Business to Business (B2B) with the launch of GrazCare for Veterinary Enterprises, Landbase for AgFirst and an online feed calculator for the Red Meat Profit Partnership (RMPP) Primary Growth Partnership programme.

That brings us to this, the final year of the project – but not of the software. We have continued to add functionality to both the core software and the mobile apps, enhancing areas such as weather recording, farm planning, time recording and reporting, mobile maps. We have also done further B2B work re-writing StockCare for Veterinary Enterprises and key performance indicators (KPI) work for RMPP, and started discussions around farm assurance.

At every stage the level of support from farmers and other partners has assured us that we are on the right track and building something that is of real, practical use for the pastoral sector.

OVERSEAS

A new opportunity presented itself, on the back of a New Zealand trade mission to Sri Lanka, to assist in the development of their dairy sector. Dairy farming in Sri Lanka is totally different to that in New Zealand, for example: the average farm is on a very small (essentially subsistence) scale with between 2 and 5 cows, and relative to New Zealand experience the feed quality and milk production are low. The aim of this work is to help the Sri Lankans lift local production and reduce the overall reliance on milk powder imports. To that end we re-purposed the Farm^{IQ} software, simplified the user interface and developed some basic reports that will give everyone from the farmer to the government agency (the Department of Animal Production and Health) visibility of the feed input, milk output and health of the national dairy herd. A proof of concept with 9 farms and the vets from 3 provinces was well received. The next step is to rollout a larger pilot across all provinces and around 800 farms.

We continue to receive enquiries from other countries, notably Australia and the United Kingdom, and it is considered highly likely that these will become target markets in future and require further software development over time.

TRAINING AND SUPPORT

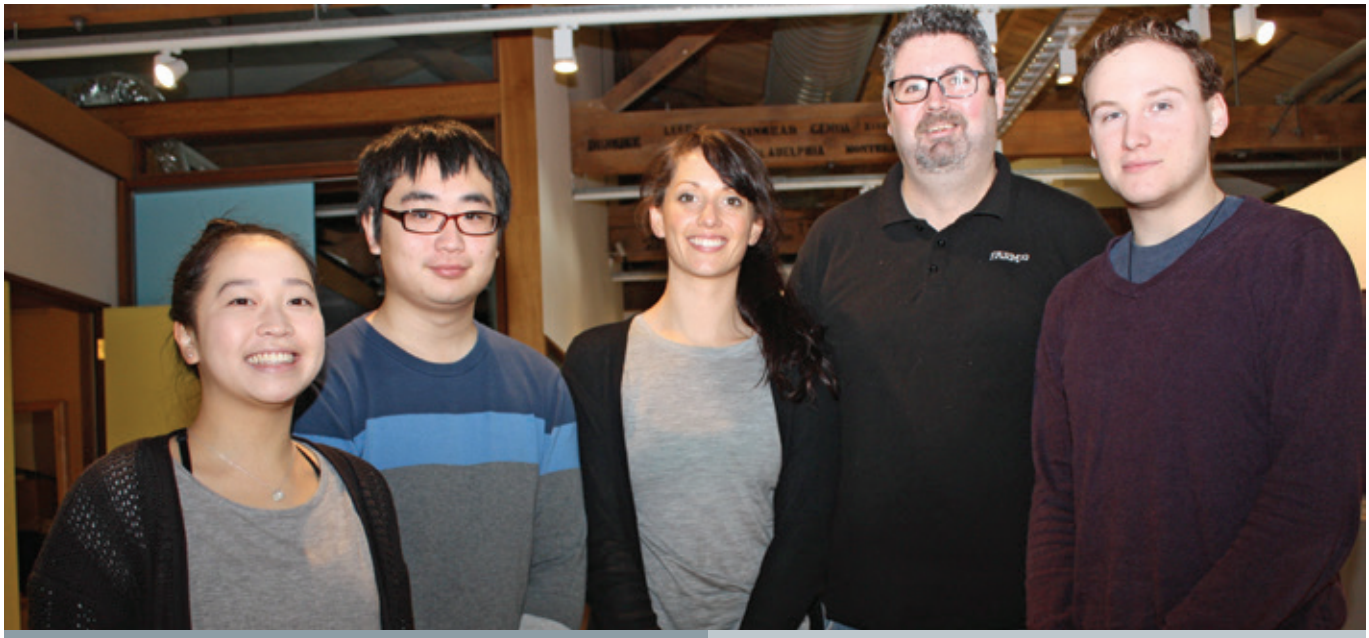
The Training and Support Team continue to provide a high-quality telephone-based support service to our ever-increasing number of users, as well as running local training sessions and workshops. They have recently released a new online help service based on ClickHelp and an online learning service based on Moodle.

DEVELOPMENT

In preparation for life after the PGP and the focus of the company shifting from the broader programme to the delivery of quality software we have taken the decision to in-source the development team and end our relationship with Fronde. We will continue to use Fronde to provide hosting and related services.

The future of the Farm^{IQ} software is bright. Development will continue to add functionality to the core system and support our original red meat customers, as well as exploring new markets, new territories and new businesses.

by John Dyckhoff, john.dyckhoff@farmiq.co.nz



The Farm[IQ] app development team in June 2017, from left: Georgia Eng, Jin Song, Elle Bryant, Aaron Stewart and Alex Thomas.

FARM[IQ] APP DEVELOPMENT

The Farm[IQ] mobile app has come a long way since August 2014 when the one thing it could do was transfer files from a weigh device to the Farm[IQ] software.

Developing a good phone app has been a critical part of the software development, because it enables farmers to record information as they go. It brings a level of convenience to the recording side of things in particular that makes using the software so much more viable for a farm business.

In 2014 very few pastoral farmers even had smartphones; now they're commonplace. Analytics show, for example, that subscribers have now recorded more stock moves using the phone app than the desktop version.

A release in May 2017 that enabled farmers to view their farm map on the phone illustrates just how far things have come. It has got to the point where the functionality of the Farm[IQ] phone app is very similar to the desktop. The main remaining area for development is adding further reporting and views to the phone app.

The health and safety features are very good too: a user can record visitors, hazards and incidents with the phone app, and view the map showing locations of hazards.

We expect the phone app will continue to develop and part of what is driving this is the improving phone technology as well as farmers wanting to do more on their phones.

TIMELINE

January–June 2011	Set up first group of IQ Farms & Technical Advisory Group
Sept 2010 to July 2011	Scoping work (farmer consultations)
2010 to 2013	Pilot development (Rezare)
July 2011	RFP issued
Early 2012	Vendor selected (Fronde)
May 2012	Development commenced
February 2013 to May 2014	Product releases (8)
May 2014	Landcorp managers (137) start to use the software
August 2014	Commercial rollout begins (and development continues)
February 2015	Release of a data link with Cashmanager Rural
July 2015	Farm[IQ] wins the Discovering Gold category of the 2015 Wellington Business Awards
October 2015	Release of a data link with Farmax
December 2015	Release of the Health & Safety module
February 2016	Release of the Environment Planning module
March 2016	Farm[IQ] accredited to the Farm Data Code of Practice
May 2016	Completion of the first business-to-business app for GrazCare
August 2016	New Map pack added
October 2016	Release of the FeedSmart calculator, built for the Red Meat Profit Partnership
November 2016	1000th farmer signs up for the Farm[IQ] software
December 2016	The Farm[IQ] software business achieves $1 million worth of annualised recurring business
May 2017	Veterinary Enterprises Group becomes a shareholder in the software business

FARM PRODUCTIVITY

PUTTING TECHNOLOGIES TO THE TEST

Critical to the success of the Farm[IQ] Primary Growth Partnership (PGP) programme has been farmer input and acceptance. A key part of this has been the partnerships created between Farm[IQ] and 11 focus farms called "IQ Farms". They have tested some of the integrated value chain approaches and technologies developed through other Farm[IQ] workstreams, including the software development.The IQ Farms, with the help of steering committees, developed business plans and conducted projects relevant to the PGP and their farm, relating to: genetics, forages and feeding, animal health, electronic identification (EID) and individual animal management.

As part of the final year the IQ Farms were asked to look back and identify projects or technologies that have added value to their business – in terms of productive and financial values but also less tangible ones such as confidence, risk management, communication and planning. Following are some examples.

MEASUREMENTS & EXPERTISE INCREASE CONFIDENCE

Rob, Jim and Willie Lawson, Moana

One of the main findings for the Lawsons was that taking measurements and keeping pasture and animal performance records enables them to make the right decision at the right time. Also, the Lawsons had regular contact with their IQ Farm steering group and experienced the value of good advice. Their time as an IQ Farm taught them they don't have to be expert in all aspects of farming; they just need to listen, plan, act, measure and repeat.

The Lawsons have recognised that climate and land factors constrain their ability to finish large numbers of lambs post-weaning so they have concentrated on increasing the proportion of lambs sold at weaning. They embarked on a programme of introducing improved forages to their easier country, monitoring pastures (growth and covers), and feed budgeting to better allocate feed to ewes. These changes increased pre-wean lamb growth rates, which led to higher weaning weights and more lambs sent to the processor at weaning. This also meant more feed to regain ewe condition pre-mating.

The Lawsons did a whole-farm analysis comparing production and profitability under the farm management policies in place in 2012 with now. Their findings were impressive – over the past 5 years they have been able to lift their whole-farm gross margin by $50/ha. In addition, Rob Lawson believes a more objective approach to farming has added considerable resilience to their business. Though a prolonged severe drought negatively impacted their productive and financial performance during the project, they minimised the damage by seeking advice, looking at the data and making the right decisions early.

ASSIGNED WEIGHING TO MANAGE INDIVIDUALS

Barry and Julie Crawford, Rosebank

To extract the full potential from any flock it is well known that ewes need to be in good condition at mating. The productivity of the whole flock can be lifted if scarce feed resources can be preferentially allocated to ewes that need it more and less to those that don't. Body condition scoring (BCS) ewes is time-consuming, and so often not all ewes are measured or it is not done often enough. The Crawfords investigated if EID technology can be used to determine a ewe's body condition score from knowing her liveweight. The project was conducted with the help of Graham Butcher (Rural Solutions) and Dr Julie Everett-Hincks (ex AgResearch Scientist).

Assigned weighing is based on taking the weight and BCS of individual 2-tooths at mating. This data is entered and stored in the Farm[IQ] software. A formula was developed to *assign* individuals their *weight* at condition score 3.5 (the condition Rosebank want their ewes to be in at mating). The assigned weights were imported to the Tru-Test indicator for use at body condition scoring in subsequent years. The indicator compares actual weight to assigned weight and drafts animals into light or heavy mobs based on the difference. They can then be managed according.

Work is continuing with mathematicians Iris Data Science to refine and determine the universality of the relationship. Financially, the assigned weighing project identified at least a $14 per head gross margin advantage by quickly and accurately BCS in ewes.

by Todd White, todd@farmiq.co.nz

MORE QUALITY = MORE PRODUCTION

Paul and Prue Ensor, Glenaan

For Glenaan Station the shorter growing season, dry summers and stony soils associated with its high-country location limit the ability to grow the good quality feed required to maximise animal performance. The Ensors and their steering team saw potential to grow species better adapted to extremes of soil moisture and temperature. Tall fescue and lucerne were identified as best able to penetrate the river terrace soils and extract water from deeper in the profile while providing good quality feed.

Glenaan followed a development plan that included sowing two ryecorn intermediate crops before direct drilling lucerne-mix pastures that are expected to last 8–10 years. The total area in lucerne increased from around 40ha in 2012 to nearly 200ha in 2017. The Farm^{IQ} software was used to plan and record the lucerne planting and to measure the impact of it on farm production. The new pastures will not hit peak potential production for another two years, but already peak season stock numbers have increased by 1400 sheep and 60 cattle. This equates to: 31% more sheep meat (+15,000kg), 7% more beef (+1,100kg) and 10% more wool (+1,700kg ultra-fine Merino). Overall, Glenaan producing an additional 109kg of produce per hectare, an increase of nearly 22% since the project began.

REPEATED MEASURES OF INDIVIDUALS AID DECISIONS

Ian Evans, Jane Cammock and Paul Crick, Mangarata

At Mangarata, situated just north of Masterton, they wanted to identify ewes that more efficiently produce lambs (measured by number of lambs scanned per kilogram liveweight at mating). To this end, technology such as EID, automatic weighing and drafting scales, and the Farm^{IQ} software were employed to collect multiple years of mating weight, BCS and scanning data for thousands of individual ewes.

The repeated measurements of the same individuals at mating and scanning each year have generated some valuable management information. Firstly, Mangarata have identified threshold liveweights at mating for their 2-tooth and mixed-age ewes – 60 and 62.5kg respectively. On average, if ewes do not achieve these liveweights at mating, conception success decreases.

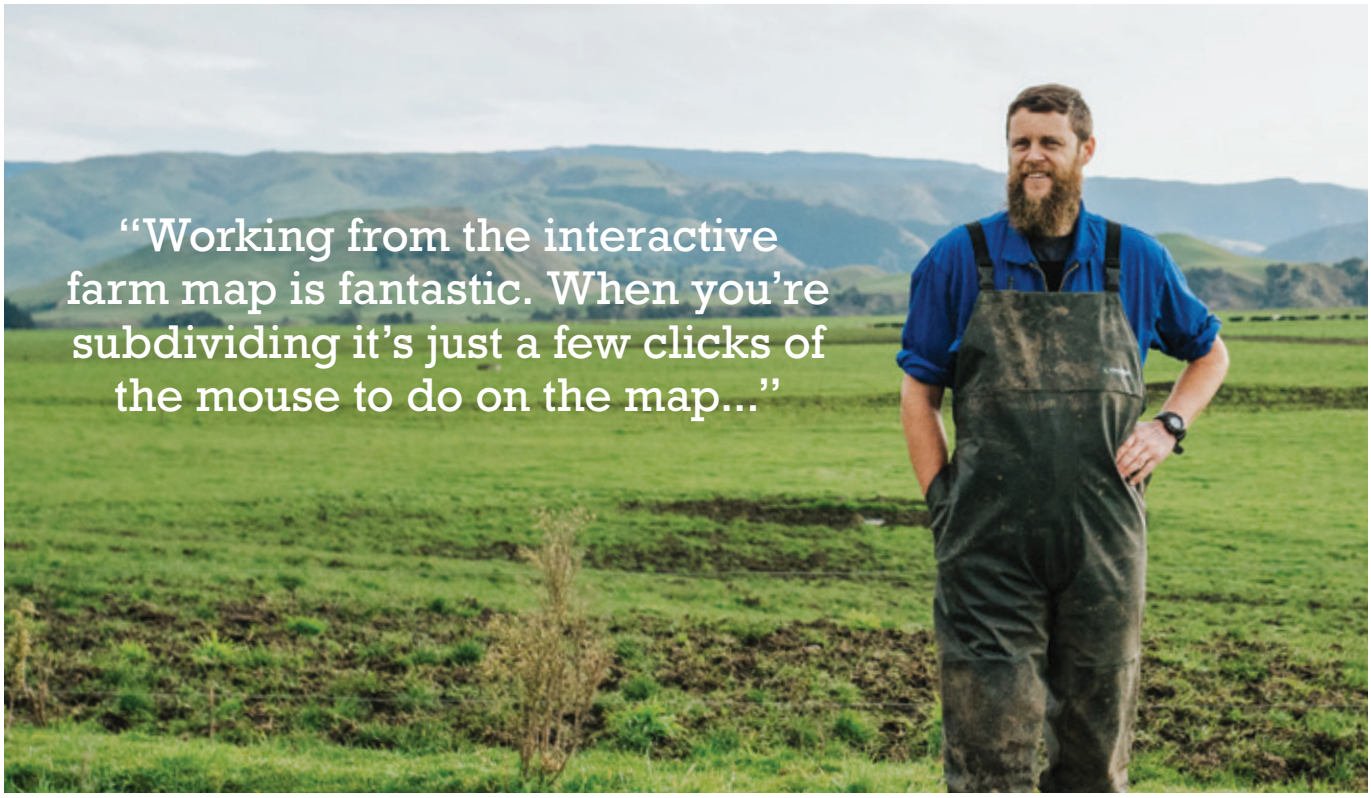
Another important discovery was evidence suggesting that an individual ewe's scanning result does not randomly vary each year but there is actually some consistency from year to year. For example, 27% of ewes that scanned triplet in 2012 also scanned triplet in 2013. This compares to an overall average of 12% of ewes scanning triplet in 2013 – a 15% increase. Similar biases were observed for single-bearing ewes – ewes that scanned single had 4% higher incidence of scanning single in subsequent years when compared to whole flock.

One objective was to identify the least efficient ewes and allocate them to a terminal mob or cull them from the flock so they don't contribute genetics to future generations. Also, in Mangarata's typically summer-dry environment, the more ewes that can be mated early to terminal sires the better. With this in mind, Mangarata have combined the mating weight targets, year-on-year scanning data, phenotypic characteristics and age to develop a management plan from weaning to mating that determines which ewes are retained in the maternal flock, which get mated to a terminal sire and which exit the flock.

FINAL COMMENTS

The IQ Farmers reported that at the start they had expected they would be: able to make better decisions based on measurement and data, exposed to new technology, able to connect paddock-level decisions to plate-level outcomes, and more profitable. At the end most felt these expectations had been fulfilled. Many had made significant progress toward or had achieved the stretch goals stated in their business plans. All agreed it was a tremendous learning journey – developing not only their farming knowledge but also strategic, critical thinking, planning and communication skills. There was a general consensus that the red meat industry is progressing toward the vision of a truly integrated value chain.

FARMER INSIGHTS



GET THE BEST FROM YOUR LAND

The Farm[IQ] software is ideal for a farming business that aims to get the best out of its land, says Hawke's Bay dairy farmer Lewis Knauf.

Wairua Dairies, 40km from Hastings, milk 1600 cows and raise their own replacements as well as running a significant cropping programme. Lewis is the operations manager for the farm, owned by a family company originally purchased by his parents Ivan and Sue in 2001, and employing 12 staff.

It's a big and busy farming operation. "If you look at the farm calendar, there's not many days where there's nothing happening." This includes managing irrigation of over half of the 645ha-effective area.

Lewis initially chose the Farm[IQ] software to set up better paddock recording. "The map views were a big selling point of the software. We're using it to keep track of what we put on each paddock and building up a paddock history over time." That includes about 160ha of cropping a year, mainly maize and fodder beet, along with lucerne, rape and winter oats.

They're putting in dams for irrigation water – and that means ongoing subdivision. "Working from the interactive farm map is fantastic. When you're subdividing it's just a few clicks of the mouse to do on the map, and it keeps the paddock history from the old area."

Another drawcard was "the ease of use of this software compared to others we've tried. The Farm[IQ] software is so easy – just click, click and you're done. You don't spend hours in the office."

The Wairua Dairies team are using the Farm[IQ] software to record information as they go. "Then I can look at it later... One guy does all the farm walks, for example. He puts that in with Farm[IQ], and then I can look wherever I am and make decisions off it... If my parents want information, it's all sitting on the Farm[IQ] software. It's great for that. They go in when they want to."

Farm[IQ] software records from the past year give him the beginnings of a plan for the coming year, such as for cropping, Lewis notes. It's a big step from the old system of making notes on paper and collating it all at the end of each season.

As they get to know the software they have seen more things they could do with it. They have found it's suitable for managing the replacements, for example. They rear 900 calves a year: selling 600 as beef-cross weaners and grazing 300 until they enter the herd. Wairua are now using the Farm[IQ] software for all the related recording. "It's effectively a 250ha grazing operation attached to a dairy farm. We use the software to keep track of their progress. We are recording their weights and all the animal health treatments. That's a big thing for us.

"We record young stock as they come in and leave. Everything gets wanded and then when it's weighed or treated that information all goes in. It makes it nice and easy – you just carry the wand, hook up to phone and send the file away to the software and it's all stored.

"The Farm[IQ] software enables you to unlock potential. It works well for us."

A HUGE DIFFERENCE FOR A CORPORATE FARMER

Using the Farm IQ software has significantly reduced costs for New Zealand Pastures, says commercial officer Greg Campbell.

The corporate farming business finishes up to 300,000 lambs a year and 6000 cattle on five dryland properties in Canterbury and Otago.

New Zealand Pastures got to know the Farm IQ software when they used it as part of a lamb trial for the Red Meat Profit Partnership programme, recalls Greg (pictured). "We could see the benefit of putting all the farms on." The last one got set up in July 2016.

"We did look around, but we found that no other farm management software had as many features as Farm IQ," says Greg. "It has something for everything we wanted. You can use it to manage stock moving on and off properties and tracking weights, as well as to record pasture maintenance, fertiliser and spraying, and also animal health and supplementary feeds – right down to managing what products we have on hand. It ticked all the boxes. It's a one-stop shop.

"Also, the user interface is very simple and logical so we could see it would be relatively easy to introduce. It appears to have been built from the farm up, rather than from the accounting side – so it makes more sense to the guys on the ground." The company has an accounting package too, and they find it easy to transfer information from Farm IQ, he says.

Using the Farm IQ software has made "a huge difference" at the corporate management level, Greg reports. Farm managers are recording information as they go and then it's available for the company to use for a range of reports for weekly, monthly and annual reporting cycles. This has vastly reduced costs. "It's taken out three or four steps."

It has also improved accuracy for reports like stock reconciliations and means the information is immediately available for decision-making. For example, farm managers can set weight targets for mobs and then as they record weights these will show progress in real time. "The managers can see the progress and management can see it too – we are both looking at same screen at same time. That's a great thing about it being cloud-based."

The reporting is very good, he says. "It is easy to run reports and see the information you want right in front of you and understand it. That's been a big plus. Everything is graphically displayed. It's better than looking at a set of figures. An example is fertiliser – which is a significant percentage of our spend each year. Now we are better able to target the fertiliser spend on areas of the farm."

Farm IQ staff are working with New Zealand Pastures to help them achieve their goals, he says. "We have regular meetings. They discuss new things coming in and what we would get value out of. And they've been very open in asking how they could do things better. That's been very helpful."

Greg is keen to see their business partners get involved with Farm IQ too. "The more parties involved, the stronger it gets and the more value there is to the users.

"The more we use it the more uses we find for it. We are learning every month – so come back to us in a year!"

> ''We did look around, but we found that no other farm management software had as many features as Farm IQ.''

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