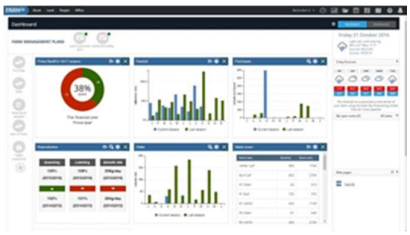

Evaluation of the FarmIQ PGP Programme

Report to the Ministry for Primary Industries

23 May 2018

Nimmo-Bell & COMPANY LTD

ACKNOWLEDGEMENTS

This report has been prepared by lead reviewer Nimmo-Bell Directors Dr Brian Bell and Michael Yap with specialist reviewer Dr Warren Parker.

We wish to acknowledge the assistance of staff and consultants of FarmIQ, and the Ministry for Primary Industries. We also acknowledge the time generously given by the people interviewed.

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1 EXECUTIVE SUMMARY

The objective of this report is to provide MPI with an independent evaluation of the FarmIQ Primary Growth Partnership (PGP) programme. The report layout reflects the primary purpose, which is to assess the achievements and expected outcomes from the programme with a strong focus on outcomes, together with a review of programme execution and governance including any lessons from the programme that would benefit other PGP programmes or the PGP.

The Farm IQ PGP programme was jointly invested in by Silver Fern Farms (SFF), Landcorp, and MPI. It aimed to create a demand-driven, integrated value chain for red meat that could grow the sector by 50% by 2025. The programme, which started in 2010 consisted of a suite of projects throughout the value chain, from on-farm production systems and genetics, to processing and analysis of market requirements.

Six Intermediate Outcomes (IOs) were specified along the value chain. As well as Programme Management and Key Indicators (IO 1) there were five individual projects: IO 2 Market Development; IO 3 IT & Database; IO 4 Genetics; IO 5 Processing; and IO 6 Farm Productive Capacity.

Over the seven years of the programme it evolved from a vision driven research programme to a commercial investment programme, which is what PGP programmes are intended to do. This evolution could not be fully foreseen from the start. It was expected to transformational and it has been, albeit most sector wide benefits are yet to be realised.

OUTCOMES: Achievements and benefits of the programme to New Zealand.

In our view, taking into account the amended 2017 annual plan, MPI and the FarmIQ partners have largely got what they expected from the PGP investment. Early set-backs due to the loss of a foundation partner, shifts in targets, change in governance focus from research to commercialism and a rapidly changing information technology environment led to amendments to the original business case as is expected under the PGP programme.

Whether the investment will prove to be worthwhile cannot be fully determined until at least 2022. During 2016 the PGP Investment Advisory Panel (IAP) and MPI had serious concerns around low software subscription uptake. These concerns have been allayed by the rapid software offtake since the beginning of 2017.

Current estimates of future benefits indicate that it will be a worthwhile investment with a gross benefit of $1.2 billion by 2025 on an investment of $125 million, a contribution to GDP of $593 million per annum and a Benefit Cost Ratio (BCR) potentially exceeding 18:1 (where a ratio of 3:1 is a satisfactory return). Thus, FarmIQ will achieve returns in excess of accepted hurdle rates for return on public investment.

Notwithstanding the big changes in culture, marketing and product innovation at Silver Fern Farms, such as their Premium branded beef, the programme overall has fallen well short of the expected short-term (2017) outcomes identified in the original outcome logic model (OLM). But, current outcomes are on target, based on the final amendments to the business plan, increased subscription uptake through a company dedicated to commercialising the FarmIQ software, and value-added meat export dollars. A Likert scale analysis of the OLM shows about a 50% achievement of full progress at 2017 and, with ongoing focus and resources 80% achievement is expected by 2025.

The programme has led to significant building of human capability-capacity in information technology in FarmIQ, major culture and capability change in Silver Fern Farms and improved business management culture and skills on farm.

The programme has made some progress on the commercialisation of an integrated value chain for the red meat sector. Increased use of EID tags in sheep developed by the programme and changes to NAIT would be valuable next steps to more effectively close the value chain feedback loop and support faster genetic gains for higher eating quality red meat. One pathway for this is marker assisted selection using the genomic SNP[1] chip developed through FarmIQ investment.

Expected economic benefits and other intended medium and long-term outcomes listed in the Final Report are realistic and achievable. The potential of dairy and offshore markets will require a smart and tailored approach to be realised. Silver Fern Farms are well placed to capitalise on the improved culture and capability to deliver higher value returns from the market for their array of distinctively branded red meat products and to reward farmers via premiums for adopting management practices and genetics that generate livestock with high eating quality meat. FarmIQ software has penetrated the large/corporate end of the sheep and beef cattle farm market. The next segment of more typical mid-sized farms with less of a business focus will need a more compelling value proposition and improved infield applications to get them on board. FarmIQ Systems' (FMS) strategy of targeting business to business (B2B) will help as will regulatory pressure on health and safety and the environment.

We agree with several interviewees who highly commended the skills of the FarmIQ software developers. Over the life of the programme the software programmers have developed a deep understanding of farm systems and what works for farmers: thus, later modules of FarmIQ were more farmer friendly and intuitive to set-up and run. Alongside Rezare Systems (and others) this is a very valuable national resource as agriculture becomes increasingly digitised and associated development of industry data standards and protocols for multi-party data sharing are required.

Spill over benefits and opportunities for other parties directly or indirectly are potentially huge. Gaining a foothold for ready access to **big data** at the farm level offers the biggest benefits; for example: to assist compliance with regulations (H&S, resource consents); supporting the "NZ story" (traceability, pasture to plate); adding value to financial accounts (supporting efficiency gains); accelerating genetic gains through increased and better quality phenotypic data; and improved customer services and customised services.

The failure to broaden shareholding in the software to more than one meat processor may limit the breadth of its uptake in the red meat sector. Some meat processors believe this was a factor that led to the RMPP programme and that this has caused overlap, and poorer use of resources and industry cohesion than otherwise could have been the case. We recognise the complexity of collaboration in the red meat sector and note that this view is not shared by all and MPI's assurance there is no overlap.

EXECUTION: engagement of expertise to address the science and marketing and other challenges.

[1] A Single Nucleotide Polymorphism or SNP (pronounced snip) is a DNA sequence variation occurring when a single nucleotide - A, T, C, or G - in the genome (or other shared sequence) differs between members of a species (or between paired chromosomes in an individual). See, http://www.dnabaser.com/articles/SNP/SNP-single-nucleotide-polymorphism.html

Industry respondents to this evaluation were critical of: the apparent lack of knowledge at programme inception around meat eating quality research by other domestic meat companies e.g. ANZCO; a lack of rigor in on-farm trial design (leading to an inability to genuinely identify FarmIQ programme effects) and skewed initial group of farmers towards the large corporates; and a long delay before specialist expertise in information technology governance and management was brought on-board to support the commercialisation of FarmIQ software and thereby also introduce new shareholders and capital to grow the business. However, from a FarmIQ management perspective, it has to be said that considerable effort was expended to make progress in all these areas, particularly in design and software development.

All participants agreed on the high standard of financial management and reporting over the life of the programme. Initially, governance focussed on compliance and achievement of the plan but this evolved to more of a focus on outcomes. This led to inconsistent reporting and tracking of metrics over time. Over the seven years significant positive progress has been made in structuring the programme, but reporting is still overly complex with lack of a concise overview.

The majority view of interviewees was the programme has delivered outputs and outcomes for the red meat sector that otherwise would not have been achieved. Innovation from other providers of software and technology to farmers has been stimulated, although the general industry view is that coordination between the FarmIQ programme and the Red Meat Profit Partnership (RMPP) could be better in the area of the Farm Management System and consistency of tools for assessing eating quality.

Our main criticism is that it is nigh on impossible to track a common set of Key Performance Indicators (KPIs) for the programme across time or be able to be verify KPIs against independent statistics that are routinely collected and reasonably current. Until recently, information on farmer uptake of software (i.e. FarmIQ benefit minus 'BAU') and net red meat value uplift i.e. red meat exports (plus the impact of tourism on domestic demand for high value cuts) have not been available. There is incompatibility between farm productivity statistics generated by Cranleigh metrics and published statistics for the livestock sectors. As well, the counterfactual was poorly defined leading to an over-estimate of programme benefits in the original business case.

Major external changes impacted on the programme which were not reasonably able to be anticipated at the start of the programme. These included the global financial crisis, PGG Wrightson (PGW) pulling out, commodity market issues (e.g. McDonalds withdrawing contracts) and Silver Fern Farm's financial position until the partnership with Shanghai Maling was finalised. All these unexpected challenges had to be addressed and this was generally done well by the FarmIQ Board and management.

Governance evolved with the transition from a grant based research model to an investment model including increased specialist information technology expertise and a clearer focus on commercialisation & PGP exit pathways.

The IAP's disenchantment with the lack of subscription uptake to mid-2016, and the associated imperative to raise capital to support faster uptake in order to secure the future financial viability of the FarmIQ farm management software service, led them to advise MPI to give serious consideration to withdrawing support to the programme. This illustrates both the challenges of the information technology development model, with its typical slow start followed by exponential growth, and the importance of getting the right combination of governance and management expertise in place to enable business growth.

LESSONS LEARNED from the findings on the programme's outcomes and its execution.

Main lessons:

- FarmIQ was one of the first PGP programmes and a major investment by the parties. MPI has learned from this experience particularly around the motivation of industry participants and how this affects public good outcomes while ensuring the industry investors secure improved competitiveness and an acceptable return on investment.
- Adaptability and agility are important attributes in PGP programme delivery and MPI must continue to facilitate increased proficiency in this.
- Commercial drivers and exit pathways should be clearly set out in the business plan and used to help shape the programme at inception. This is a learning from FarmIQ that is now adopted for new programmes. This approach provide clarity on market requirements and how commercialisation of outputs can be achieved early whilst also fostering ongoing innovation. It also ensures a strong focus is kept in building a compelling value proposition for farmers based on meeting both off-farm and on-farm needs (farmer pull) rather than technology push (where technology is the applicable area/product).
- The early versions of FarmIQ software were too complex as on-farm software requires simplicity of use. The development of automated (preferably in field) data entry via mobile devices was a big step forward and planned further developments in direct data capture will add impetus to farmer uptake.
- Stretch science, such as genomics in FarmIQ's case, is an important element in building programme impact but will generally require a strong commitment from programme partner's post-MPI investment to see the full benefits realised. For FarmIQ it is vital Silver Fern Farms works to close the feedback loop to farmers via EID and sustain a high-quality working relationship with Beef+Lamb Genetics (BLG) to get the full benefits from genomic assisted breeding plans, particularly around eating quality. This is important because the main payback on the FarmIQ investment (70%) will come from increased farm productivity (better management decisions, enduring genetic feed conversion efficiency and product attributes)
- Greater gains could have been made if Silver Fern Farms had worked more openly and co-operatively with other meat companies from programme inception (i.e. a NZ Inc approach). In this respect it is pleasing that there are now regular catch-ups to review extension practices and learnings within the PGP network (including RMPP, Clearview Innovations, FarmIQ, Marbled Grass Fed Beef, Pioneering to Precision, and Spring Sheep Milk Co). However, it was apparent from interviewee comments that more effort needs to be made by MPI and PGP participants to effectively communicate information about the PGP network collaboration to the senior echelons of the companies involved in the programmes.
- To track programme delivery, the Programme Steering Groups should ensure the programme KPIs are clear and distilled onto a one-page dashboard and manage these by exception. Part of this will be to measure progress against a clearly quantifiable counterfactual so that actual programme gains can be realistically evaluated. A one-page dashboard will also facilitate improved communication on KPI progress with all boards and wider stakeholders.
- Upfront investment in inventory and value chain segmentation is an important insurance policy in the face of disruptive products (such as synthetic meat and plant-based proteins) entering the marketplace e.g. via assurance; better eating quality etc.

- Silver Fern Farms recognised the supply of traditional beef cattle is limited and that because demand is increased via the FarmIQ tools, efforts to produce premium quality beef via dairy herds should be accelerated. This would also support improved animal welfare such as through 'bobby free dairy' from breeds with inherent high intramuscular fat (IMF) such as Wagyu. Here the current PGP programme for "Marbled Grass-fed Beef, led by Brownrigg Agriculture Group Limited and Firstlight Foods Limited, is directly relevant to making such gains[2].
- Meat processors interviewed for this evaluation indicated getting the balance right between competing for throughput supply to support plant viability versus offering a sufficiently large premium to encourage the uptake of on-farm management practices for improved eating quality and increased total value derived per animal remains an ongoing challenge. Whilst beyond the scope of this PGP programme to address this tension and the emergence of meat substitutes such as synthetic foods, the MIA could facilitate discussion between meat companies on how they can collaborate to move more of the carcass into higher value products for the mutual benefit of both processors and suppliers. Here the gains made by Silver Fern Farms and farmers from the FarmIQ value chain approach (along with other red meat PGP programmes) offer some good insights for this discussion.
- While not part of the FarmIQ programme, the need to further develop the "NZ Inc Story" for New Zealand grass-fed red meat was a common topic of feedback from interviewees. They noted FarmIQ software supports the imperatives for 'end to end' supply chain traceability and livestock welfare; and, the assurance of eating quality helps position New Zealand (and thereby enhance individual meat company brands) in the minds of discerning consumers in high margin export and the high-end tourist markets. Here the NZTE 'NZ story' collateral could be leveraged and the MIA could benchmark its member performance against offshore exemplars (such as in the EU) to gain insights on how this story can be credibly build.

Implications for the PGP in terms of lessons, benefits, risks, value chains, sectors and future strategy:

- Government programmes like the PGP offer MPI more of a sector facilitation role as long as the MPI people have the right mix of commercial, technical and governance skills and experience. This could be achieved, for example, by clearer phasing of programmes and associated terms for PSG members and other input providers to cover the development, establishment and roll-out as suggested by meat industry respondents. As well MPI could identify strategic 'gaps' in the PGP portfolio (e.g. relative to the Primary Sector Science Roadmap[3]) and intentionally seek out expressions from companies to address such opportunities. This is a challenge MPI say they have already taken up.
- Information technology is advancing exponentially so trying to plan in detail seven years in advance is futile. Whatever is planned is likely to be disrupted. The learning is to stay small and flexible and enable agility via programme variation, which is what MPI now advocates for in programmes.
- For MPI, there is further scope to encourage collaboration between FarmIQ Systems Ltd and RMPP to identify opportunities for alignment and for their mutual benefit.

[2] See https://www.mpi.govt.nz/funding-and-programmes/primary-growth-partnership/primary-growth-partnership-programmes/marbled-grass-fed-beef/

[3] Available at: http://www.mpi.govt.nz/news-and-resources/science-and-research/primary-sector-science-roadmap-te-ao-turoa/

Commercial arrangements required to ensure FarmIQ Management Systems (FMS) achieves commercial sustainability in the near future are:

- Dilute existing shareholding through the introduction of one or more new shareholders who see ways to grow FMS's value and enhanced market penetration (now achieved).
- Increase FarmIQ capital, board skill sets/networks, phone app enabled tools with much increased inter-operability (recognising that these are an ongoing focus).
- Extend underwriting beyond 2018 as FMS projections indicate they will need equity injections till 2020.
- Further adjust the balance of FMS Director skills to include better capacity to build a bridge to Fonterra-LIC's AgriGate and thus help futureproof data delivery in the pastoral sector
- Create a sharper more compelling farm value proposition for the next 50% of generally more cautious adopters in the "40-65 years old one-person operators" cohort.
- Demonstrate time and cost savings over competitors in the highly contested spaces around compliance for H&S, staff management and environmental planning (with possibility of benefits from mergers and acquisitions).
- Not overlook the meat quality-genetics value potential opportunity as the cost of EID tags for sheep decreases.

2 BACKGROUND

MPI's background information provided for this evaluation stated the following about the programme:

> "FarmIQ, is a Primary Growth Partnership (PGP) programme, jointly invested in by Silver Fern Farms, Landcorp, and MPI, which aims to create a demand-driven, integrated value chain for red meat that could grow the sector by 50% by 2025.
>
> The programme, which started in 2010, consists of a suite of projects throughout the value chain, from on-farm production systems and genetics, to processing and analysis of market requirements.
>
> Central to the demand driven integrated value chain is a Farm Management System (FMS), which acts as an enabler for disseminating critical information through the value chain. The programme's intended wider benefits listed within the 'From Plate to Pasture' 2010 business plan included:
>
> - Growing the red meat industry to $6.3 billion by 2025 (50% increase on value in 2010);
> - Annual net economic benefit grows from $13 million in 2010 to $2 billion by 2025;
> - Industry projected to grow by 1.5% compound beyond 2025;
> - Employment growth of 7,800 full time jobs;
> - Increasing GDP by $1.1 billion by 2025.

FarmIQ's target outcomes were to increase sustainability of the red meat sector, increase collaboration of sector participants along the value chain, increase productive capacity and increase ability to produce products to consumer specification."

Significant modifications were made to these wider benefit targets as the programme evolved, such as FarmIQ software modules for farm environmental management and improved health and safety.

At the time FarmIQ was being negotiated, the IAP expected investors to propose transformational and aspirational targets in their PGP proposals. At a minimum, investors needed to align targets with a compelling vision. While it is widely recognised that the intent was to achieve "additionality" rather than 'business as usual" [4]incremental change, the targets subsequently, as in the case of FarmIQ, sometimes had to be made more conservative, while remaining additional to 'business as usual'.

2.1 Objectives

The objective of this report is to provide MPI with an independent evaluation of the FarmIQ PGP programme. Two final reports are to be delivered: a confidential report to MPI; and a public report which is the confidential report excluding commercially sensitive information.

The evaluation is to primarily assess the achievements and expected outcomes from the programme with a strong focus on outcomes. It is also to include a review of programme execution and governance and any lessons from the programme that would benefit other PGP programmes or the PGP as a whole.

[4] See Auditor General's Report at https://www.oag.govt.nz/2015/primary-growth

2.2 Approach

Information was obtained about the value chain benefits for meat, farmer adoption and on-farm applications of FarmIQ software and genomic technology via interviews and a desktop meta-analysis of FarmIQ case studies and reports.

The interviews included:

- Farmers – users and non-users of FarmIQ software
- Agribusiness and farm management consultants
- Veterinary services
- Meat processors (Silver Fern Farms, ANZCO, Greenlea Meats and Progressive Meats)
- Animal breeding and genetics experts
- Equipment supplier
- Farm input supplier (via Farmer director of LIC, Ballance AgriNutrients)
- MPI PGP programme administrators and FarmIQ PSG members
- FarmIQ Chair, Directors (Landcorp) and CEO
- FarmIQ Systems Ltd CEO
- Beef+Lamb NZ and Economic Service executives
- PGP Investment Advisory Panel
- Deloitte New Zealand
- NZIER senior economist who assessed the programme in 2011 and 2014.

In total 44 people were interviewed. The schedule of questions which guided the farmer and non-farmer interviews are presented in Appendix II. Interviews typically ranged from 45-75 minutes; some were in person, many were by telephone.

All interviewees spoke freely and candidly about their experience (and non-experience[5]) of the FarmIQ programme, particularly the software system, but not so much on the benefits arising from the focus on the value chain. Conversations were recorded by hand written notes on key points regarding benefits (a simple SWOT), productivity impacts, factors enhancing and preventing adoption; and overall views of the value realised from the investment made into FarmIQ PGP programme (from both a 'taxpayer' and private sector perspective).

Limited pre- and post-adoption information on FarmIQ programme productivity gains was gleaned from the interviews for two main reasons. First, some interviewees had only used the software for less than three years and second, the attribution of gains to the FarmIQ programme was confounded by other factors influencing farm and supply chain performance including seasonal conditions, additional input of external advice and review of management practices as part of the FarmIQ focus farm 'package' and changes in technology (notably rapid advances in the internet and phone technology and applications (apps)).

Nevertheless, interviewees all provided a qualitative assessment of the FarmIQ programme and generally gave examples to back their statements. Where applicable they also outlined how they intended to use the software, better red meat genetics and market-supply chain information in the future. They volunteered their opinion of 'value for money' with caveats to this. Collectively this

[5] The evaluators were interested to also learn the viewpoints of farmers who had not adopted FarmIQ software.

information was used to assess progress to date with each element within the FarmIQ logic map and thus an overall indication of programme progress as at 30 June 2017.

3 OUTCOMES

3.1 Expectations of MPI and FarmIQ Partners: Actual verse Target

Based on the findings from the interviews and desktop analysis our assessment of progress to 30 June 2017 in meeting each element in the simplified 2016 version of the FarmIQ Outcome Logic Model (OLM) and the programme overall is summarised in Chart 1. Our assessment of the likelihood of meeting the 2025 targets is summarised in Chart 3.

As at 20 July 2017, 986 paid subscriptions, representing 4.5 million stock units or 5.1% of national stock units for the use of FarmIQ software had been issued. Silver Farm Farms had increased its 2017 winter premium for carcasses meeting the Eating Quality (EQ) System® prime grade from 25c to 40c/kg carcass weight (ca. $3.5m payments). Some red meat sire breeders were using genetic information to breed animals with higher levels and particular types (e.g. Omega fatty acids) of intra-muscular fat (IMF). The latter is correlated with higher eating quality meat products.

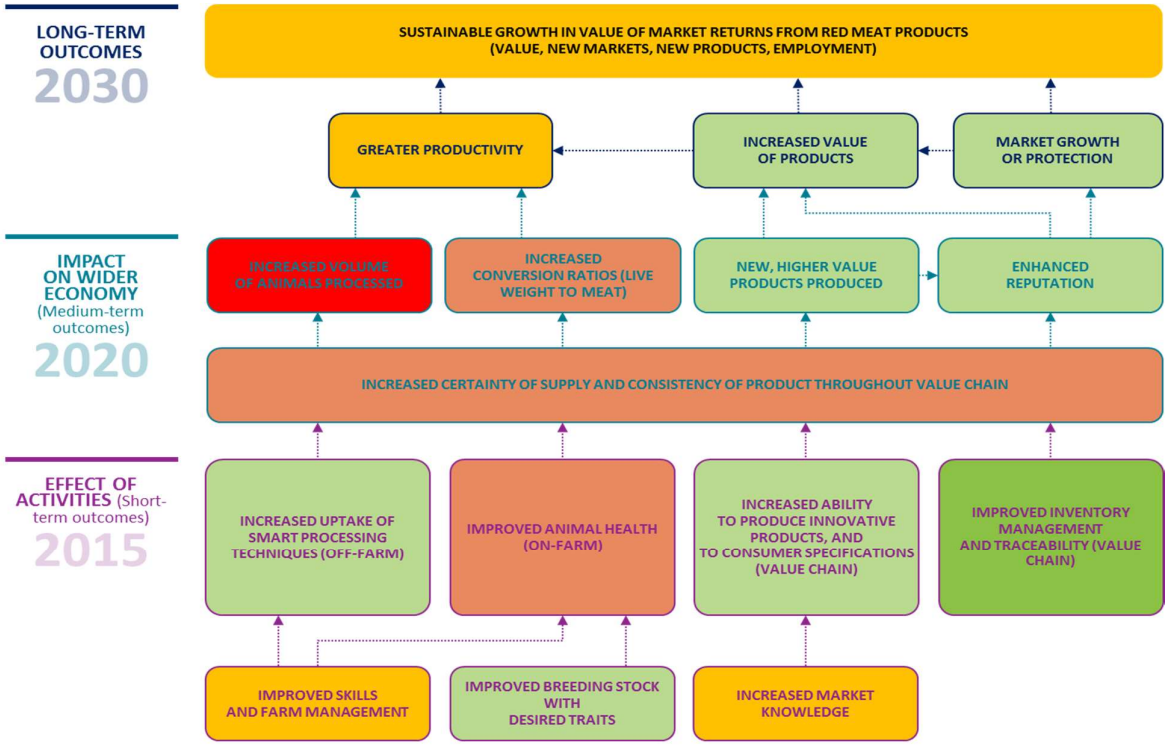
While increased market knowledge, improved skills and farm management, and productivity gain are rated overall as “some progress”, for those involved it is more like “good progress”. However, the challenge remains the limited number of farmers using FIQ software to date – 1,428 as of August 2017. Based on the base case of 23,000 farms, 1,428 represents 6.3% of farms.

FarmIQ’s own summary of the programme with respect to the outputs of new products, farm management systems, genetic evaluation and improved farm productivity were as per expectations. These were not always at the forecast scale (sales/uptake) and not as connected along the chain as envisaged in the original Business Case. As per the Programme Plan for 2017, only the value add product sales and deer numbers were below target.

In our view, three critical factors in the original business case logic model have constrained progress in meeting the PGP programme outcomes – delays in developing a ‘’farmer-friendly” comprehensive FarmIQ software solution (not till 2014) and putting a commercial vehicle in place to deliver this (late 2015); associated slower than planned uptake by farmers of the software; and a low use of electronic identification tags (EID) to close the feedback of phenotypic information to farmers on the meat quality attributes (that in turn can be linked back to the genetic parentage) of their animals. In particular with respect to cattle, present regulations for NAIT allow meat processors to only trace animals back to the farm from which animals are sourced, leading some farmers (such as Aberdeen Angus breeders) to double EID ear-tag their cattle. FarmIQ can link the whole chain, which puts the focus back on NAIT to see if there are ways to upgrade their criteria for access to data that will allow animals to be tracked back to their parents.

An alternative view is that the FarmIQ gains to date have been substantial due to the size of challenges and time taken to get new products to market, the EQ system in place and premiums paid to farmers (and then link these to software).

Chart 1: Likert Scale assessment of 30 June 2017 progress in meeting elements in the FarmIQ programme

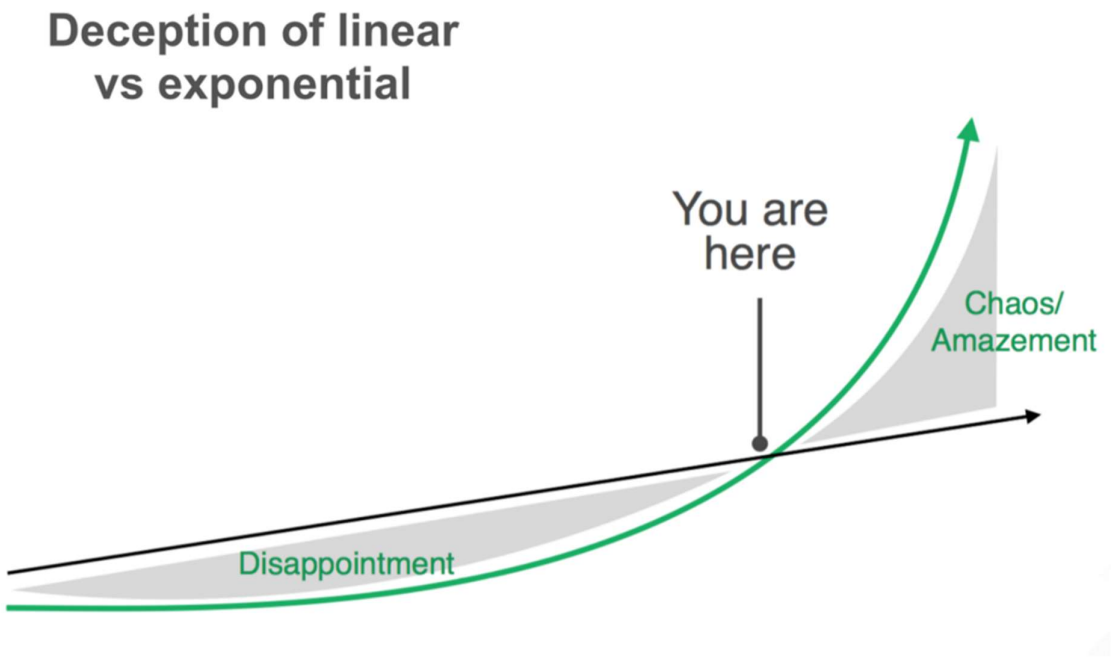


Progress made to 2017	
1	Excellent progress
2	Good progress
3	Some progress
4	Limited progress
5	No change

Source: adapted from FarmIQ

FarmIQ Systems Ltd is an information company and appears to be following the development pathway of other successful information companies (see Chart 2). This is epitomised by a slower than linear initial growth period (disappointment) followed by exponential growth (chaos/amazement). The IAP's disenchantment with the lack of subscription uptake to mid-2016 and consideration of withdrawing support, reveals the difficulties in resourcing the non-linear information technology development model. This is not surprising given previous non-IT technology breakthroughs have typically occurred with linear outcomes. Arguably, FarmIQ failed to effectively communicate the business model to the IAP. As at August 2017, FarmIQ Systems appears to be entering an exponential growth phase for subscriptions: June subscriptions 934, July 986, August 1,428. FarmIQ Systems Ltd is unlikely to be able to maintain this rate of growth out to 2025, because of the limited market for pasture-based farm software, however, it is still expected to be a worthwhile investment.

Chart 2. Exponential growth of information technology companies compared with linear growth of previous technological developments



Source: FarmIQ Systems as at 2016/17

The key strategy to grow subscriptions is business to business (B2B), which was the original strategy of SFF and PGW, though with new partners. While FarmIQ Systems Ltd ultimately see dairy as a bigger market, the programme objective was to develop an integrated red meat value chain in order to increase the productivity of sheep and beef cattle farms and the profitability of the sector overall. The 2018 target of 1,300 subscriptions was exceeded in August 2017.

No change in total red meat output can be attributed to the FarmIQ programme at this stage (although a 3% improvement has been made over the FarmIQ farms on a per animal basis) for two primary reasons. First, larger scale land conversion from sheep and beef cattle to dairying than the original business case assumptions occurred through to about 2014 (when the 2014 National Framework for Freshwater Management with water quality limits came into force). Second, there is a lag of several years in the flow through to farm output from improved genetics and farm management practices.

Limited evidence was found of gains to date in animal health *per se*, although farmers using FarmIQ software have an improved integrated capacity to record drench and other livestock treatments, and through this identify otherwise non-obvious problems impacting livestock performance. Also, 36% of those using the system have reduced the defect incidence rate against an upward trend in incidence.

Importantly, most interviewees identified the growing imperative from the market, regulators and the wider public for high integrity, traceable assurance of high on-farm standards of animal welfare and environmental management. Indeed, these license to operate factors and the emerging threat of synthetic substitutes for livestock products (produced in market with a very low total

environmental footprint) have become much stronger drivers for FarmIQ software adoption than the original primary objective of increasing returns from the red meat supply chain.

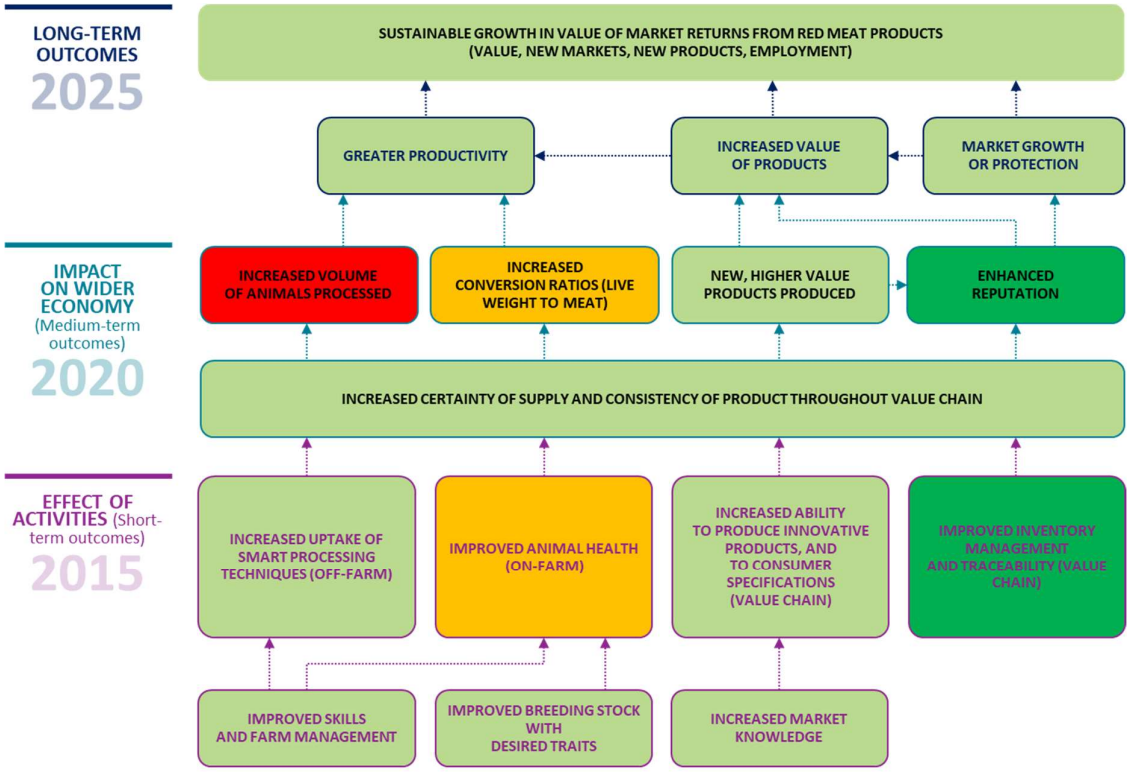
The overall conclusion from the OLM review, is that while the programme has put in place the building blocks essential for achieving programme goals and outcomes, progress to date is well short of the original business case estimates. In the main there are sound reasons for the lower than planned level of achievement and, as outlined later in this report, useful lessons (see Section 5) for MPI (and others) can be drawn for this early, large and ambitious PGP investment. The interviews, as could be expected for a seven-year programme, revealed that in hindsight a number of aspects of the programme set-up, approval and delivery could have been done better (see section 5). These learnings provide a basis for increasing the value from both the current PGP portfolio and any new programmes that are launched. However, the majority of interviewees thought the programme had delivered outputs and outcomes for the red meat sector that otherwise would not have been achieved. Innovation from other providers of software and technology to farmers has been stimulated, although as described later, coordination between the FarmIQ programme and the Red Meat Profit Partnership (RMPP) could have been better.

3.1.1 National outcome assessment

The FarmIQ programme progress can also be assessed by directly comparing actual sector metrics with the assumptions used in the original business case (see Table 1). Here, the proxy for the business as usual "without" FarmIQ scenario is provided by actual sector output metrics because, while the national averages include FarmIQ farms, the small number of these will have had negligible impact on the averages reported. This confirms the qualitative assessment provided by the OLM rating (Chart 3).

Our assessment rates most outcomes as likely or very likely (see Chart 3). Only three outcomes are rated with a less than 50% chance of being met in 2025: improved on-farm animal health and increased conversion ratios of liveweight to meat (30% to 50%) and increased volume of animals processed (very unlikely). This supports our conclusion that overall the economic benefits and other intended medium and long-term outcomes are realistic and achievable (see section 3.6)

Chart 3. Likert scale assessment of potential outcomes by June 2025



Caveats

1. S/holders capitalise FarmIQ to 2020
2. FarmIQ uptake >40%
3. FarmIQ (&RMPP) & AgriGate collaborate
4. EID tags widely adopted & processor feedback loop closed
5. 'Throughput vs quality' tension is managed

Here FarmIQ relates to FarmIQ Systems Ltd.

Likelihood to meet 2025	
1	Very likely 85%+
2	Likely 50-85%
3	Some 30-50%
4	Poor 10-30%
5	Very unlikely

3.1.2 Farm level outcomes

At the individual farm level, changes in output and financial performance pre- and post-FarmIQ have been documented to varying degrees through case studies including by BakerAg using their annual farm performance benchmarking tools. However, these do not [yet] allow gains in productivity to be explicitly attributed to the use of FarmIQ programme software, genetic tools or better processor/market feedback. The relatively short time frame that the FarmIQ final outputs have been available is one reason for this; other reasons are between year differences in seasonal weather and market conditions, changes in farm personnel and, importantly, the way farm measurement protocols were put in place to track FarmIQ effects. The latter provided a pre- and post-FarmIQ adoption comparison and as such include seasonal as well as other effects like increased consultant

advice. A longer run view will provide a better indication of whether higher levels of performance are sustained and how FarmIQ is enabling this.

Case studies published on the FarmIQ Systems Limited website identify on-farm performance and financial gains from sire comparisons, better timing of livestock sales, diagnosis of reproductive performance and improved hogget lambing performance[6]. These benefits from FarmIQ software were attributed to the farmers and managers having better diagnostic and decision-making information.

Landcorp provided some examples of performance lifts associated with their farm managers using FarmIQ software. After three years live use, Landcorp management estimate they are getting 20-25% of the gains possible from FarmIQ. Big cost savings have been made through more efficient collection and aggregation of data; and the software now drives on-farm performance plus a connection to customers particularly on eating quality. Return on investment is hard to quantify, but is estimated by management at this stage to be 40-60%.

The farmer interviews confirmed the latent on-farm potential of FarmIQ software, livestock marketing and meat genetics is high because most are using only some of the software modules (see Chart 5, Section 3.3.1) and, as explained earlier, the linkages to animal parentage for meat quality traits are still limited.

3.2 Investment returns

In this evaluation of FarmIQ we have relied on estimates of return provided by NZIER and Cranleigh. Our qualitative assessment showed no good reason to put forward an alternative view.

In May 2017 NZIER reassessed the economic benefits expected to be provided by the FarmIQ programme (NZIER 2017). They found that most of the benefits will accrue after 2017 and therefore the analysis relied on assumed take-up rates expected over the 2017-2025 period. They concluded that while the programme aims to create an integrated demand driven value chain approach to the red meat sector most of the benefits are likely to accrue on farm.

While there are potentially multiple benefits from the FarmIQ investment, the values of these are critically dependent on the counterfactual and rates of adoption. NZIER (2017) found (based on Deloitte estimates) the business as usual (BAU) in the original proposal was overly pessimistic and also assumed a decline in output from the red meat sector by 2025, despite the trend being a rising one. It appears that at the time of business case preparation the impact of land use change into dairy and the onset of the global financial crisis had a larger than merited negative influence on BAU estimates for red meat. In contrast, views about the take-up rates of FarmIQ outputs in the original proposal were also overly optimistic (20%-30% by 2017 and 40%-65% by 2025). The current NZIER forecast indicates a lower than projected take-up rate (10% in 2017; 30% in 2025). NZIER believe these latter assumptions place a question mark over the maximum benefit likely to be achieved.

NZIER, supported in an analysis by Cranleigh (2016), revised these key assumptions and arrived at a gross output of approximately $0.1 billion in 2017 and $1.2 billion by 2025. The 2025 figure assumes an uptake rate of 30%. This compares original business case estimates of $0.35 billion in 2017 and $2.8 billion gross output in 2025. Contribution to GDP derived from input/output tables were estimated (assuming a contribution to GDP at 45% of gross output), respectively to be $45 million in 2017 and $593 million in 2025.

[6] See case studies at http://www.farmiq.co.nz/whatsnew/section/case-studies

Cranleigh state that the key assumptions underpinning their model were sourced and verified from leading sector stakeholders and industry experts. This resulted in major percentage gains in carcass weight per farm between the base, 2017 and 2025 as shown in Table 1.

Table 1. FarmIQ: percentage change in weight of carcass per farm (kg) compared with base

	Base	2017	2025
Semi Finishing Farms Lamb	0	71	85
Finishing Farms Lamb	0	21	30
Semi Finishing Farms Beef	0	6	57
Finishing Farms Beef	0	47	57

Source: derived from Cranleigh 2016

It is unfortunate that closer scrutiny was not made of overly optimistic business case projections of benefits from FarmIQ prior to approval as this set up the programme for perceptions of failure when elements of work inevitably fall far short. This is not to say that the investments are bad. MPI say that in the early days of the PGP, applicants were encouraged to be aspirational. Now applicants are encouraged to quote high, medium and low estimates of benefits/returns. This is a positive change and key learning for the PGP.

Such an analysis was carried out retrospectively on all the PGP programmes by NZIER (NZIER 2014). FarmIQ showed a 69% reduction in benefit compared with the business case. After adjusting for an improved counterfactual and converting the aspirational benefit to a mean estimate, a cost benefit analysis of FarmIQ over 30 years at a discount rate of 8% showed the mid-point NPV was $3.5 billion. In their 2017 updated estimate of benefit, NZIER more than halved the uptake rate as well as further reducing the gross output net of the counterfactual to $1.2 billion in 2025 (NZIER 2017). FarmIQ Systems Ltd has exceeded the 2017 uptake target with 16% of sheep and beef cattle farmers subscribing to the software.

With cumulative benefits of $2.9 billion and cumulative costs of $124 million to 2025 (discounted at 8%) this results in a BCR of 18:1, well above an acceptable rate of return to the Crown.

3.3 Achievement of expected short-term outcomes

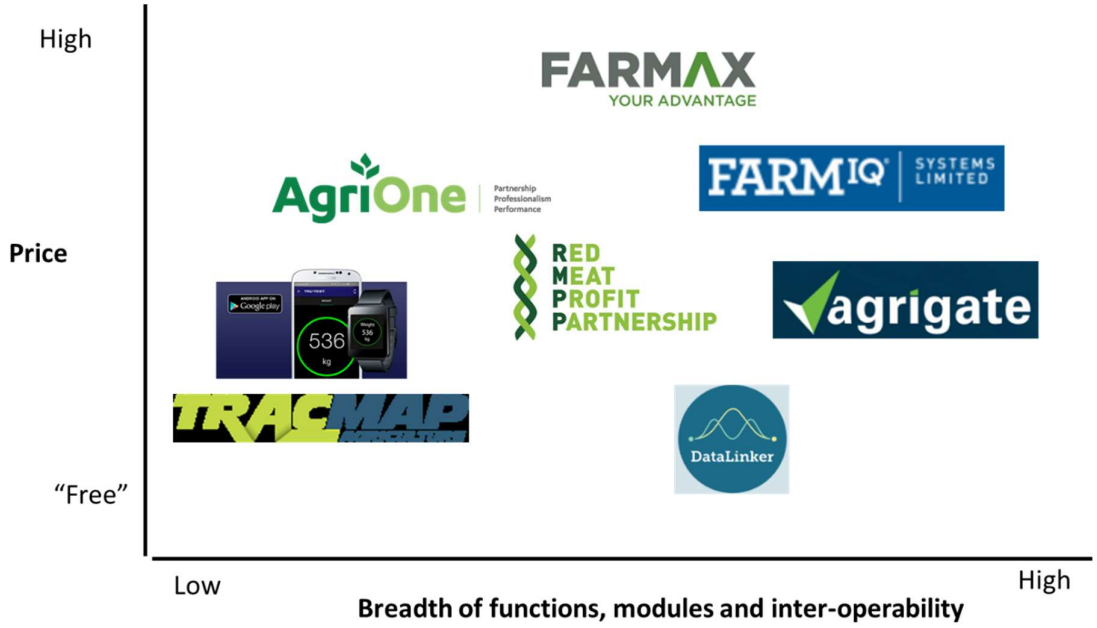
3.3.1 Farm Management Software System

Uptake of FarmIQ software subscription packs has been lower than target. The original business case assumed the system would be used by the partners as part of the supply chain. In the end, while there are links, it has been offered separately. This separation helps in part explain the slower than expected uptake. As at July 2017 out of a total of 986 subscriptions, 434 are with partner organisations and 552 directly to farmers. The total represents 11.0% of New Zealand's 9,000 sheep and beef cattle farmers, compared with an original target of 36% for 2017. Based on the base number of farms of 23,000 (including dairy) the uptake is 4.3%. For packs directly subscribed by farmers the average su/farm is 8,107 for a total of 4.5 million su.

The proportion of SFF farmers subscribing to FarmIQ is less than originally anticipated. Understandably, SFF did not want to push the system if the value chain was not clearly and directly supporting its use. The risk to supply was too great if farmers were turned off and choose another processor. Further, SFF getting back inside the farm gate was not seen as SFF core business by some farmers.

A brief review of the competitor landscape (see Chart 4 for some examples) suggests achieving year-year on growth with the next tier of ''less computer inclined" farmers will be more difficult, even with new shareholders and additional capital, and because of the market response from substitute software options for dairy such as AgriGate[7] (the collaboration between Fonterra and LIC). As well, Farmax with a stronger farm systems planning-analytical capability than FarmIQ, has repositioned its offering[8], the RMPP[9] is developing simple benchmarking tools; and equipment suppliers such as Tru Test[10] (and Gallagher, Pratley and others) are offering increased record keeping and analytical capability embedded in farm equipment such as weighing scales and milk cooling systems. Several of the alternative farm management software suppliers also offer flexible pricing by packaging different modules and have good levels of inter-operability with other sources of farm records such as weather stations, animal record systems and banks. Overall, FarmIQ ranks highly on functionality and favourably on price compared with other software offering farm management support. The closest rival is AgriGate, which is specific to dairy. And it should be noted that some software such as Farmax, which has stronger farm systems planning capability is complementary to FarmIQ rather than a substitute. Indeed, FarmIQ links readily to Farmax to enable subscribers to realise the synergies between the two sets of software.

Chart 4: A sample of New Zealand farm management software sources and tools.



[7] See https://www.agrigate.co.nz/
[8] See http://www.farmax.co.nz/
[9] See http://www.rmpp.co.nz/
[10] See https://group.tru-test.com/en

Research commissioned by the RMPP (2016) highlights the challenge facing FarmIQ in expanding its subscription base beyond the 10-15% early adopters. UMR surveyed over one thousand farmers in 2015 and 2016 to better understand their uptake of digital technology. Only 18% of the farmers had used a farm decision support tool (in contrast, FarmIQ Systems Ltd had 61% of these in 2017). However, 62% of those contacted by UMR had used a financial management tool, 51% benchmarking tools and 45% a computer planning tool like a spreadsheet. Farmers under 40 and those with bigger farms were found to be more likely to use digital and benchmarking tools. Importantly, more than half the farmers (52%) were prepared to adjust farming practices subject to seeing evidence of them working first on farms that were trusted sources of expertise.

FarmIQ software is now boosting subscriptions by leveraging its network of high-performing exemplar farmers (who are now they are coming out publicly in support of FarmIQ software benefits for them). As well, with respect to computer literacy, FarmIQ software is leapfrogging over conventional introductory digital tools to easier-to-use (and essentially ubiquitous) mobile phone apps, automated electronic data entry and "tailorable" software solutions. Even so, it is a major leap to move from 16% of sheep and beef farmers currently subscribing to 30% given the above research results.

The presence of competing or complementary software – domestic and offshore - does not mean FarmIQ software cannot succeed. As Charts 5 and 6 illustrate respectively for farmers and farm input-services suppliers, the company will need to continue strengthening FarmIQ's value proposition, ease of use and interoperability.

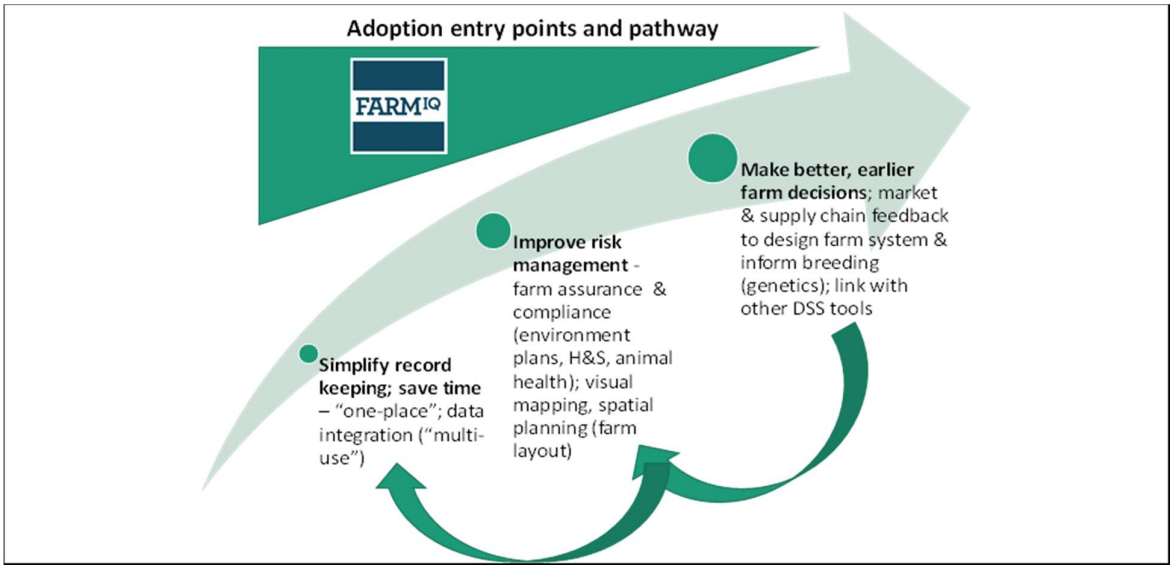
Chart 5: Factors identified by interviewees that influence farmer adoption of software.

Farmers spoken to generally were not using FarmIQ software's full suite of modules although they noted that migration to other modules was likely to occur over time (Chart 6). Most were seeking a software solution that is easy to use, intuitive, had automated data entry and met growing compliance requirements (Chart 6). Except for the latter, these expectations are fully consistent with

a 2001 study of Canterbury dairy farmers. The ability to link with phone apps was viewed very favourably. Thus, adoption is now being driven less by the original business case of value creation from supply chain feedback and more by farm record keeping, assurance and compliance as illustrated in Chart 6. Larger and consistent premiums for better eating quality product and better substantiation of the cost benefit for EID tagging, especially for sheep, could encourage more farmers to use FarmIQ software's full capability.

Bringing on-board small-medium owner operator farms will be another challenge for FarmIQ Systems Ltd. Meeting regional council environmental standards is an attraction. An alternative is Beef+Lamb's paper-based Land & Environmental Planning (LEP) tools (and the RMPP). FarmIQ does an online version of these with Beef+Lamb's permission. It is just a question of whether a farmer wants to do it on paper or online. As more farmers adopt FarmIQ software and the advantages of one time only recording become obvious, online recording will grow.

Chart 6: Entry points for farmer adoption of FarmIQ



Agribusiness consultants are an important influencer of what tools farmers adopt (see Chart 7). Their views on FarmIQ software versus alternatives reflected the diversity of knowledge about the software and level of direct experience. The value of environmental and farm assurance tools - spatial planning, mapping and digital photography – came through strongly as a driver of adoption. Likewise, the ability to act as a farm database platform, customise to a farm and link with other data – fertiliser, livestock and paddock records; and health and safety – were seen to be positive, differentiating advantages of FarmIQ software. The software's relative ease of use and the high cost of developing a substitute from 'scratch' were also identified as factors supporting FarmIQ software adoption. In-paddock phone apps were viewed as a big step forward by enabling farmers, rather than advisors, to do their own record keeping and compliance.

In this respect and as noted earlier, consultants and farm input suppliers frequently commented on the need for appropriate and verifiable environmental, including climate change and animal welfare records. Further, because there are too few suitably qualified consultants to do all the environmental-farm systems work (e.g. Waikato healthy rivers) farmers are going to have to step-up their record keeping and have these well organised, readily retrievable and suitable for third party

auditing. And, because consultants will tend to work with their current client's and those with the best capacity to pay for their services, the rest effectively have no choice but to adopt an easy to use, computerised, record keeping system for farm assurance and compliance.

Chart 7: Factors influencing farm input (services, equipment, products) suppliers' selection of farm *systems* software.

Not all consultants were enthused by FarmIQ software (and, although not verified by this review, it is very likely a portion of consultants have a low awareness of FarmIQ software capabilities). One, with a large practice, commented on its complexity and higher cost compared to alternatives (e.g. well-designed spreadsheet tools and exploiting drop box functionality for data sharing). However, they acknowledged some farmers with EID were getting benefits from weighing and processor feedback; and were therefore adopting a 'wait and see' attitude before deciding on whether to adopt within their practice.

The views of farm equipment suppliers, veterinary services and meat processors provided insights, into both the strengths and weaknesses of FarmIQ software, and the challenges it faces. A large user in the veterinary sector adopted FarmIQ software as a data platform because it was more affordable than funding the replacement of their old database. For them, FarmIQ software allows large amounts of data from multiple sources to be processed into succinct information to support better

management decision making. As well, because regulatory and market access drivers are rapidly becoming stronger, they believe it is essential New Zealand exporters quickly get better at telling the 'NZ Inc story' about farm assurance and supply chain integrity. So, they are positioning FarmIQ software to provide an animal health "passport" for meat companies, while concurrently aligning value-adding services to clients (e.g. invoicing for services; pre-emptive supply of medicines). AgriGate was identified as FarmIQ Systems Ltd's principal competitor. LIC, because of its links to the national animal evaluation dBase and its MINDA system, was seen to be a key influencer on dairy farmer's choice of software. Irrespective of how the future unfolds, the veterinary practice considered the PGP programme to be very worthwhile due to its development of "plate to pasture" thinking, systems and tools that New Zealand agriculture absolutely needs to succeed.

Our overall conclusion is FarmIQ software is unique in the market in terms of its breadth and capacity to be a pastoral (and wider primary) sector database platform. The main competitor is Fonterra-LIC's AgriGate package for dairy farmers, but it does not reach across into sheep, beef cattle and deer farming. FarmIQ has in place the elements it needs to succeed: strong shareholder support for working capital to sustain rapid recruitment of subscribers; introduction of further B2B shareholders that can reach subscribers through different sales channels and value propositions; expert independent governance for an ICT entity that can 'marshal' the agri-sector expertise; and dilution of original shareholders' dominance.

3.3.2 Genetics for improved eating quality, higher value products

The genomic SNP[11] chip developed to assist Marker Assisted Selection (MS) was an early, important and large piece of work funded by the FarmIQ programme. Through this Quantitative Trait Locus (QTL)[12] were discovered that can enable the earlier and more accurate identification of sires with superior eating quality. The heritability of eating quality – such as via intramuscular fat (IMF) and specific fat types – is reasonably high (>0.4) meaning gains can be made in flocks and herds, providing the breeding plan makes room for this trait. And, that can be a challenge when farmers want to prioritise performance traits (birth rate, weight gains to weaning, survival to sale, disease tolerance) with a larger short-term bottom line impact. Silver Fern Farms have exploited the phenotypic expression of animals with better eating quality meat in their proprietary Beef^{EQ} programme, albeit limited to this point because of the lack of comprehensive EID trace back (see Section 3.3.3). The fact that this can be done with FarmIQ software seems to have escaped some SFF farmers.

Beef+Lamb Genetics (BLG) is a key enabler for the economic value of genetic gains from FarmIQ's investment to be expressed across red meat breeds and species (cattle, sheep, and deer). Established in 2014 when they secured MBIE Partnership funding ($6m pa over 5 years), BLG consolidated several industry genetic improvement assets – Sheep Improvement Limited (SIL), Combined Progeny Test (CPT) and Ovita – under a single entity with a separate board and executive. BLG see FarmIQ software and their established working relationship with FarmIQ Management as a critical element in their mission via the capacity to "*collect good quality data at lowest possible cost*"

[11] A Single Nucleotide Polymorphism or SNP (pronounced snip) is a DNA sequence variation occurring when a single nucleotide - A, T, C, or G - in the genome (or other shared sequence) differs between members of a species (or between paired chromosomes in an individual). See, http://www.dnabaser.com/articles/SNP/SNP-single-nucleotide-polymorphism.html

[12] A quantitative trait locus is a section of DNA which correlates with variation in a phenotype. Usually the QTL is linked to, or contains, the genes which control that phenotype. QTLs are mapped by identifying which molecular markers correlate with an observed trait. This is often an early step in identifying and sequencing the actual genes that cause the trait variation. See, https://en.wikipedia.org/wiki/Quantitative_trait_locus

from commercial herds and flocks and to readily link the records of the breeders that supply them sires.

Our conclusion is the role of FarmIQ software in assisting productivity gains via genetics for better quality (and *all things being equal* higher priced) red meat is still in its infancy. While the elements to enable faster genetic gains in red meat traits sought after by consumers have been established, they are not yet widely operationalised or necessarily linked with FarmIQ (e.g. other meat processors). Ensuring all of the necessary third party software systems are in place to support FarmIQ Systems Limited interfaces with BLG (and through it ram and bull breeders) and meat (and for that matter dairy) processors is very important for driving farm productivity gains (feed conversion efficiency, better quality meat) and supporting the wider value proposition for its software. The interviews conducted for the PGP programme evaluation suggested the genetics aspects of the business plan have not received as much attention it deserves and, this in turn if not rectified, reduces the likelihood of the original business case red meat sector GDP gains being realised by 2025.

3.3.3 Red meat market information and improved processing

Silver Fern Farms (SFF) have commercialised and branded their 'pasture to plate' eating quality system. Development of Beef^{EQ} included extensive taste panel work with the support of Texas A&M University as well as input from Lincoln and Massey Universities, and AgResearch. One of the elements Silver Fern Farms produced as a result of the eating quality work was a premium "Reserve" brand and eating pack, which was launched in Germany/EU and domestically, and steps are now underway to launch into North America. Changes in processing plant methods, a new grading system and trained graders (who undertake regular refresher/calibration courses to ensure consistency within and across plants) have enabled this. A SFF Beef^{EQ} Manual has been produced for farm suppliers to inform them how to alter their on-farm management to meet the quality standards. Farmers with livestock meeting the top Beef^{EQ} grade were initially paid a 25c/kg carcass (cc) premium. This has been increased to 40c for the 2017 winter ($75 a 300kg carcass steer and about 7% of the $5.70/kg cc schedule offered by competitors). SFF are managing the strength of the demand signal because of the limited supply of prime beef cattle (about 60,000 head). While the average hit rate for the premium grade has climbed to ca 32% of prime cattle processed, the best property is achieving 80%. SFF believe this has provided a point of difference for the consumer. Interestingly, SFF elected not to mandate the adoption of FarmIQ software as part of the Beef^{EQ} package because they did not want to "*artificially cap supply*". As described in Section 3.3.1 about 17% of SFF cooperative members are subscribers to FarmIQ software.

SFF claim they did not find big enough differences in eating quality to launch a Lamb^{EQ} analogue, given they are trying to manage very large numbers of lambs. They attribute this to high growth rates of lambs and their relatively young age at slaughter. Other meat companies hold a different view – for example, ANZCO with more than 20 years of experience in improving the eating quality of pasture-fed red meats disagree. Beef+Lamb Genetics also do not subscribe to SFF's interpretation of

the lamb trial data, pointing to the success of the PGP Omega Lamb programme[13] with Alliance and the Headwaters Group to confirm their point.

Irrespective of the criticisms of the FarmIQ eating quality programme, SFF were very positive about the benefits they have accrued from "The Silver Fern Farms Eating Quality (EQ) System®". This included a major shift in company culture to be consumer-facing and the value generated through the formation of an innovation team. Eating quality is now a key part of SFF strategy and embedded into the company "mind set". Contrary to this, SFF did not appear to have a strong view on the imperative to better link carcass information back to farmers to use in the breeding plans and sire purchase decisions. It may be that some within the company do, but there is always a concern about the risk of being seen to favour some breeders over others.

It is important to note SFF tried hard to get Meat and Livestock Australia (MLA) on-board as an original programme partner in order to access MLA's already well-advanced red meat integrity and eating quality systems. They were rebuffed. A partnership would have enabled the large body of Australian work to have been utilised in a mutually beneficial manner for grass-fed beef. The links BLG have subsequently formed with MLA are therefore pleasing, as they offer sound prospects for the potential of genomic assisted breeding to be realised faster in both countries.

3.4 Extent of human capability-capacity development

We agree with several interviewees and FarmIQ management who highly commended the skills of the FarmIQ software developers. Over the life of the programme the software programmers have developed a deep understanding of farm systems and what works for farmers: thus, later modules of the FarmIQ software are more farmer friendly and intuitive to set-up and run. Alongside Rezare Systems[14] (and others) this is a very valuable national resource as agriculture becomes increasingly digitised and associated development of industry data standards and protocols for multi-party data sharing are required.

As outlined in Section 3.3.3, a major change in culture and capability has occurred within Silver Fern Farms marketing and processing and product innovation teams. The flow-on benefits of this are large due to SFF's size and influence in the red meat sector. A caveat to this is that SFF continue to grow collaborations with other processors so that industry wide gains can be realised. Interviewees commented on negative perceptions held of SFF (especially in the early years of the FarmIQ programme) and its dominance in FarmIQ Systems Ltd as a barrier to others becoming engaged. SFF are aware of this and propose to dilute their shareholding from the present 75% to 37.5%. The lesson here in evaluating whether to invest government funds is that MPI should assess the landscape for barriers to collaboration and whether these will prevent programme outcomes being realised.

The original FarmIQ focus farmers provide a source of knowledge and networks can be accessed to help promote software adoption. Several of these leading farmers are engaged in other research programmes and in this respect, they play an important role in setting the direction for and stimulating on-farm innovation.

[13] See http://omegalamb.co.nz/ the Headwaters group, established in 2006 to breed ewes with high levels of fat to thrive in New Zealand's high country. With some 50 farmer shareholders and approximately 250,000 breeding ewes, a high fertility, resilient ewe that produces lambs with strong growth rates and unique fat attributes has been developed.

[14] See, http://www.rezare.co.nz/

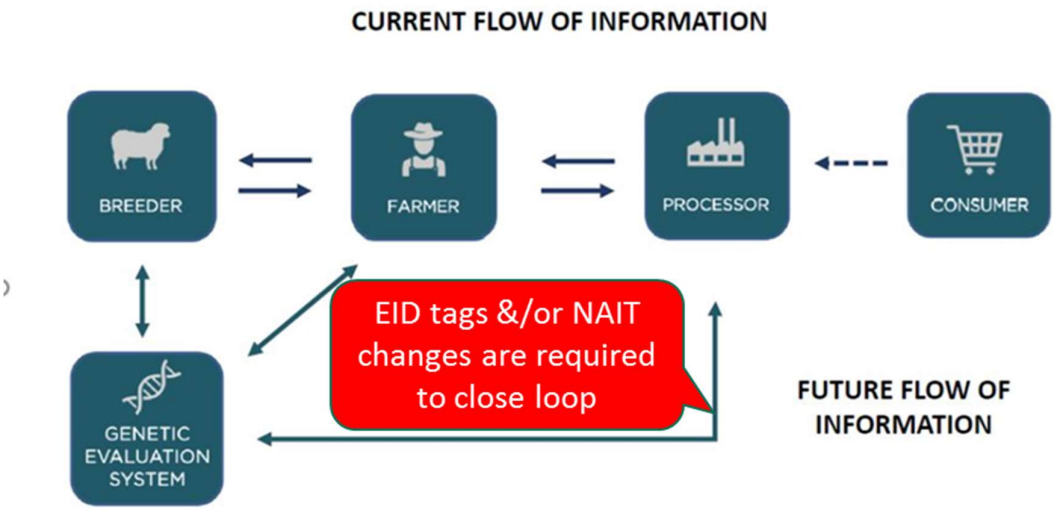
We agree with FarmIQ management that the programme has created a new marketing/product development team in Silver Fern Farms that is important for the future success of the New Zealand meat industry given the company's market share, trained students in Silver Fern Farms (meat science) and encouraged farmers in meeting market expectations demonstrated through an increase in the Beef^{EQ} pass rate.

3.5 Progress on commercialisation of integration of the red meat value chain

The establishment of FarmIQ Systems Ltd (FMS) in 2016 was to attract additional capital and expertise to enhance the commercialisation of the software and was a vital step in securing on-going benefits for the PGP investment. Ideally, this would have happened earlier, but it took a long time to get SFF to agree to firstly non-SFF farmers using the system, and then to agree to other shareholders and get these parties on board (given their own circumstances). FarmIQ had requests for investment prior to SFF agreeing in principle and earlier the early (circa 2009) enquiry by RMPP partners was not supported by SFF. The situation has now changed significantly with a non-meat processor investor (VetEnt) in FarmIQ Farming Systems and a national rural sector supplier (Farmlands) participating.

As described in Section 3.3.3, SFF have integrated some genomic information into their Beef^{EQ} programme and are paying farmers premiums for cattle that meet the criteria. And, as outlined in Section 3.3.2, Beef+Lamb Genetics (BLG) are well advanced in developing MAS-parentage tools to assist ram and bull breeders improve the productivity of commercial flocks and herds (as illustrated by Chart 8). The datalink software under development by BLG and RMPP, paired with EID will be a critical enabler for delivering additional value to breeders, commercial farmers and processors.

Chart 8. Closing the red meat supply chain feedback loop to commercial farmers and breeders



Source: BLG, 2017

FarmIQ management state that the programme has not made as much progress as they would have hoped on the commercialisation of an integrated value chain for the red meat sector. However, they note all the essential parts are available to do so. With regards to red meat species, beef cattle with Beef^{EQ} is very close (absent a formal contract). Lamb^{EQ} has not developed to the same extent due to their view that lamb eating quality factors are manageable at processing and quality measurement systems not fitting with the speed of the lamb chain. In addition, the GFC and commodity shocks

stopped end customer contracting back e.g. McDonalds on bull beef. Offering a contract to farmers without a back to back arrangement to the customer has high risk.

3.6 Extent medium and long-term expected benefits are realistic and achievable

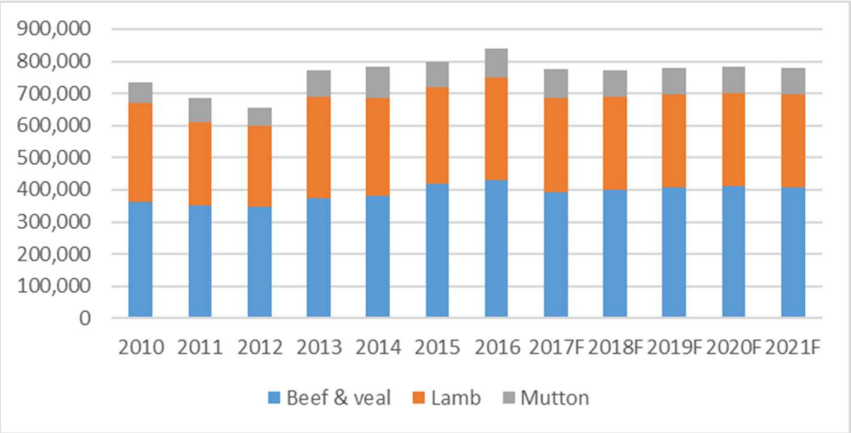
Most interviewees indicated that while FarmIQ had taken longer than expected to reach its current position it had and was continuing to generate useful outputs. However, the delays as quantified by NZIER, and, as yet relatively poorly closed market-processor feedback loop for phenotypic measures of meat attributes, reduces the likelihood of achieving the red meat value uplift envisaged in the original business case. Gains are expected to accelerate once there are 9-10,000 FarmIQ subscribers.

All parties contacted commented that the programme was well managed (especially financials) and has brought essential change that otherwise would not have occurred and on that basis, was worthwhile. Based on their experience with this large programme, some interviewees believed it would better to pursue smaller programmes in the future that can be managed with more agility.

FarmIQ software broke new ground seven years ago, but exponential IT gains made since have overtaken aspects of the original concept, in particular the strong focus now on getting different software packages to 'talk to each other' and incorporate data collected through new mechanisms such as drones and sensors. This obviates the need for a fully integrated "stand alone" system and allows a full supply chain (versus farmer-centric) view to be more easily adopted. FarmIQ Systems Ltd's shift toward automated data entry is critical because system maintenance of 4-5 hours per week is too onerous. Nevertheless, there are a lot of good things in FarmIQ software which can be built on including improving farmer friendliness of use and better documentation of how they can increase on-farm value through its use.

Environmental limits for water quality under the 2014 National Framework for Freshwater Management mean that the production output gains envisaged in the original logic map are unlikely to be achieved, this is even more so with the new Labour/NZ First/Green government. Productivity lifts will need to come via cost efficiency and high average prices for meat. Given the introduction of nutrient limits has been known for well over a decade (e.g. as evidence by Horizons' One Plan and the removal of nitrogen from Lake Taupo) it is perhaps surprising (in hindsight) that FarmIQ proposers had not factored in the restrictions on land use intensification more strongly. However, at the time of proposal development, the Government was working its way out of the GFC and Christchurch earthquake, and dairying was performing relatively strongly. The result was land use change from sheep and beef cattle to dairying (and horticulture) has been more substantial than in the original business case. Looking ahead, the combination of higher carbon prices and water quality limits for sheep and beef cattle will see more land set aside for forestry, riparian management and biodiversity restoration. Collectively these factors mean total red meat output will unlikely increase (see Chart 9) and, if it does, it will be via animals sourced from the dairy industry, even if with fewer dairy cows. This includes the growing possibility of 'bobby-free' dairying driving more dairy x beef animals into the supply chain.

Chart 9: Volume of red meat exports (y-axis, tonnes) for the period 2010-2021[15]



Source: MPI

Continued growth in the New Zealand sheep and beef cattle market will become more difficult to achieve as growth becomes more dependent on the large group of farmers who follow the innovators. Crucial to this will be the value proposition put forward by FarmIQ software around helping farmers to cost effectively comply with environment (and to a lesser extent health and safety) regulations. In addition, further gains can be made in animal productivity by automating record keeping associated with identifying sire, dam and progeny for genetic selection using electronic ear tags (EID) and on farm radio frequency identification (RFID). FarmIQ Systems Ltd's competitive advantage is the ability to capture information once and use this with multiple applications for multiple purposes, thus saving time and identifying opportunities to improve financial performance.

The RMPP running introductory level courses for digital tools and the belief is that this is as far as it will go. Rather than focus on introductory computer training and spreadsheets, FarmIQ software has gone straight to mobile phone apps, automated electronic data entry and tailored software solutions. Even so, it is a major leap to double the number of farmers subscribing. The bulk of farmers prepared to adjust will be watching the innovators for clear signals that the software systems save time and increase profits before they move. The innovators are a pool of advocates and mentors for the next tier of farmers and the main reason for the current rapid growth in subscriptions. A challenge for FarmIQ Systems Ltd is to continue adding functionality to keep the innovators happy.

A key factor in whether FarmIQ will achieve the expected long-term benefits will be how well FarmIQ Systems can keep up with technology change given changes in market demand. Business assumptions will need to be continually updated for new technologies like blockchain. It is almost impossible to predict where the state of the art in digital communications will be in 2020 let alone 2025. In an information based environment the pace of development has jumped to an exponential growth path where price/performance doubles every year or two. Disruption is the expectation in this space[16]. FarmIQ Systems will be successful by accessing caches of existing information it does

[15] For the data series see, http://www.mpi.govt.nz/news-and-resources/open-data-and-forecasting/situation-and-outlook-for-primary-industries-data/

[16] Ismail, Malone and van Geest 2014

not own and making this information available to its customers, without manual input, to meet their specialised needs at each node of the customer to farmer value chain. We think the FMS business model and capability is agile enough to make this happen.

Our view is that scaling up alone will not be enough to ensure success. FMS will need to continue to transform itself while delivering on customer needs to remain relevant and competitive. The base is there to do this with a good chance of success.

3.7 Direct and indirect spill overs

The software platform has created an opportunity to completely modernise industry information systems to the benefit of all that want to use it e.g. exploit the internet of things (IOT), blockchain etc. Genetics has updated the industry platform for lamb (all traits), reduced cost and rebuilt the deer industry system (GBS). FarmIQ has been a key contributor to the stimulus for change.

The negative comments raised by all meat processors primarily related to the lack of alignment with the RMPP PGP programme launched in November 2013. SFF claimed that this had delayed progress with their eating quality programme and duplicated some aspects of FarmIQ software. Also, some of the RMPP participants lamented the lost opportunity for wider meat industry collaboration in the FarmIQ PGP programme at its inception. These matters are now 'water under the bridge' and it is difficult to identify how MPI could have altered the outcome as PGP programmes are industry-led. Nevertheless, this highlights the reality of sector politics and personalities, and the big challenge in identifying ways to circumvent or resolve their effects.

3.8 Unintended outcomes or consequences

FarmIQ was one of the first PGP programmes to be approved and it created a political overhang at the time as others saw the level of government support that could be achieved and the potential commercial benefits. It increased the competitive tension between SFF and other meat companies, with strong industry personalities getting in the way of the potential benefits of collaboration. Now that the PGP programme has matured and sector personalities changed this is not such an issue.

Though MPI has encouraged a significantly greater degree of collaboration between programmes, there remains scope for the PGP and MPI to enhance synergies between the RMPP and FarmIQ in the development and use of software tools for farmers.

4 EXECUTION

4.1 Engagement of expertise to address science and marketing challenges

While the programme engaged the right level of expertise across the board (within the bounds of information publicly available), the challenge was to get partners from outside the programme in a very competitive industry to link in and collectively change the behaviour of the participants in the value chain.

That said, there appears to have been a lack of awareness of prior eating quality research and, despite initial external advice, a lack of rigour in on-farm trial design to allow effects of FarmIQ to be distinguished from (and quantified relative to) 'business as usual' farm management improvements At the farm level, the initial small, well- resourced group of farmers representing a narrow range of farm situations the software would be applied to meant that the views of a broader more representative sample of the majority of sheep and beef cattle farmers was addressed later rather than earlier.

Some interviewees questioned whether FarmIQ had given sufficient attention to research already reported on barriers to farmer uptake of software such as that undertaken by AgResearch and others. This is despite FarmIQ engaging AgResearch extension specialist for this purpose.

4.2 Effectiveness of programme structure, systems and management

The programme did have a complicated structure with a commercial Board and a programme steering group. A significant overlap of membership (including chair) and transparent reporting kept things in tune, however, MPI at the time felt "left out" as it did not attend Board meetings as a partner. The primary challenge was that commercial drivers of the partners/shareholders did override the programme at times, such as PGW's exit and Silver Fern Farms needing to protect their investment.

The Board did well to recover from the early set back of losing original partners, PGW and Tru Test. Positively, Tru Test kept engaged and became an investor; and PGW are now looking again at how they can use the resulting FarmIQ software. Landcorp came on-board when Livestock Improvement Corporation (LIC) decided not to invest. Both the Board and Management commented on the restrictions imposed by having to 'stick to the original budget' over a seven year period (including inflation and technology changes).

All participants in the FarmIQ programme commented on the high standard, and comprehensive financial management which tracked all partners' contributions and expenditure.

MPI's view of FarmIQ programme management is that a good job has been done on:

- Building a programme team and winding it down
- Engagement with MPI
- Adapting to the evolution of the PGP fund
- Leading other PGP programme managers
- Collaboration with other programmes

At the same time MPI is critical of management for:

- Not seeing MPI as a partner at times
- Treating MPI as a tick box exercise at times
- Focusing on the farm management systems communication when a more holistic approach was needed.

The main reviewer criticism of governance and management is on the lack of strategic alignment, and simplicity (one page dashboard) and consistency in reporting. If anything, there was over-reporting relative to governance needs and because of the high level of complexity of the programme an inability to easily track programme KPIs through time.

4.3 Achievement of milestones and achievement measures

Excluding value add sales and deer numbers that are below target, the programme is close to where it would be in the 2016/17 Programme Plan. Due to the early emphasis on research and development and thus lack of certainty of knowing how things would develop, FarmIQ believe it was difficult to start with a common and enduring set of KPI's from the beginning. As well, due to the competitive nature of the industry, reporting on all areas of work was viewed as a risk. In that respect, the programme was subjected to a number of OIA requests (from competitors) in the beginning which gave rise to significant concerns from Silver Fern Farms (which is not directly subject to OIA but, MPI and Landcorp are).

Our main criticism is that it was nigh on impossible to track a common set of KPIs for the programme across time that can be verified against independent statistics that are routinely collected and reasonably current. FarmIQ recognise this as an issue noting that KPI's moved to some degree as the programme evolved and that no independent statistics were available where they were doing something new.

Assessing achievement of milestones and key programme indicators provides useful lessons and direction for future monitoring and evaluation. In assessing achievement, it is recognised that FarmIQ is one of the first programmes funded by PGP. We note PGP management has undergone several changes since 2010 with respect to achievement monitoring:

- Original outcomes were meant to be aspirational with stretch targets
- Early emphasis was on contractual delivery of outputs
- Articulation of outcomes became important from 2013 with the introduction of outcome logic models making expectations transparent to all parties
- Delivery of outcomes expected by funders is the responsibility of the Programme Steering Group (PSG) which is similar to a joint-venture board

To assess achievement, programme indicators from 2010 to 2017 were collated:

- Extracted indicators, baseline, targets and timeline from schedules 6 and 7 of the 2010 contract.
- Extracted reporting against indicators and changes to indicators and/or targets from annual programme plans since 2010 and from the final programme report. The annual programme plan as it superseded schedule 7 of the 2010 contract and the outcome indicators in each preceding annual programme plan.
- After completing the preceding steps, FarmIQ populated a number of data gaps.

Our findings on FarmIQ management's reporting on 2010-2017 indicators are summarised below:

1. The indicators are grouped under six intermediate outcomes (1 to 6)
    a. IO 1 – Programme Management and Key Indicators
    b. IO 2 to IO 6 relate to individual projects
        i. IO 2 – Market Development
        ii. IO 3 – IT & Database
        iii. IO 4 – Genetics
        iv. IO 5 – Processing
        v. IO 6 – Farm Productive Capacity
2. In the 2010 contract:
    a. A few indicators have no target year for achievement
    b. A few indicators are not clearly defined – e.g. industry value gain for every $ earned (cents), capability growth
    c. A number of indicators have no baseline data while other baseline data do not relate to any indicator
3. A number of indicators were added through the annual programme plans resulting in over 50 indicators across seven years. As annual programme plans replace the prior year set of indicators, it is not clear if indicators have been dropped/replaced or if targets have been revised (except for animal numbers). FarmIQ disclosed that some indicators in the 2010 contract were ignored as they do not make sense (e.g. capability growth in on-farm management) while others dropped as they were not possible to measure, or the output was found to be infeasible (e.g. long-term customer orientated contracts). As SFF became concerned with OIA requests, detailed reporting on market oriented indicators was reduced.

4. Actual results from 2012 to 2017 are virtually non-existent
    a. No reporting seen on most indicators
    b. Reporting is a high level summary that is difficult to relate to indicators
    c. Presentation can be confusing as actuals and targets are shown in the same column
    d. Where there is reporting, it is sporadic with no "like for like" reporting in the following years
    e. Indicators shift between IO groups where they make more sense
5. Reporting has enlarged to an unwieldy size. In the final programme report, three sections are devoted to output and outcome reporting as each section attempts to summarise the succeeding section.

FarmIQ commissioned two reports to quantify the outcomes for the period 2017 to 2025. These are the Cranleigh (2016) value chain model gains and the NZIER (2017) net economic benefits. While applying different methodologies, NZIER (2017) found that its modelling results were similar to Cranleigh (2016). However, tabulating the numbers (only start and end year numbers are available) from the two studies reveal inconsistencies in the magnitude of numbers as shown in Table 2. Some of the difference can be attributed to the Cranleigh modelling not incorporating the updated assumptions.

Table 2: Comparison of NZIER gross output and Cranleigh value chain gains (na = not available)

($'millions)	PV at 8%	2017	2018	-	2024	2025
NZIER Incremental gross output (target)	2,900	100	na	-	na	1,200
NZIER Incremental gross output (BCR 4.7:1)	582	Na	na	-	na	na
Cranleigh value chain gains	-	88	na	-	na	424

Achieving the NZIER (2017) $1.2 billion incremental gross output in 2025 translates to a high benefit-cost ratio (BCR) of over 18:1 compared with the international 'success' benchmark of 3:1 to 5:1. To assess the feasibility of the $1.2 billion uplift by 2025, we identified key assumptions underpinning the forecast and compared these with FarmIQ targets. As NZIER (2017) does not have industry level assumptions, key indicators were sourced by a 'different methodology but similar result' to Cranleigh (2016).

The two sources of value chain model gains in Cranleigh (2016) are on-farm productivity and market gains. The key value drivers for the two value sources are:

- FarmIQ uptake rate (penetration)
- Improved weight gain
- Higher weaning percentage
- Branded vs commodity product price
- Branded products proportion of sales

These key value drivers from Cranleigh (2016) are compared with FarmIQ targets (from summary outcome diagram in final programme report) in Table 3, though with different end-year timeframes (2022 vs 2025).

The comparable indicators are uptake rate and weaning percentage. The uptake rate of FarmIQ targets are calculated from the number of users of software. Given that FarmIQ software users are typically larger than average sheep & beef cattle (S&B) farms (as evidenced by average su per subscriber), the uptake rate is higher in terms of the percentage of total industry animals.

Weaning percentage shows FarmIQ is the same as Cranleigh for beef cattle in 2017 but lags for lambing performance (125% vs 140%). In 2022, FarmIQ lags Cranleigh but there are three more years for FarmIQ (from 2022 to 2025) to achieve the Cranleigh assumption. Weight gain numbers are not comparable.

For marketing value chain gains, which contribute 30% of total value chain gains, two items need to be deducted from "value add sales" to be comparable to "marketing incremental earnings before income tax, depreciation and amortisation" (EBITDA). These two items net out the counterfactual value add sales and commodity values from the incremental value add sales.

If FarmIQ achieves its user targets, it will most likely achieve the total value chain gains forecasted in Cranleigh (2016) for the following reasons:

1. Software uptake rates exceed those of Cranleigh (higher (39%) and sooner (2022) uptake rate)
2. Ability to catch up with weaning percentage by 2025 (10 percentage points, and this is also within bounds of seasonal differences due to climate effects))

Table 3: Comparison of key value drivers adopted by Cranleigh (2016) and FarmIQ targets

	Cranleigh		FarmIQ	
	2017	**2025**	**2017**	**2022**
Uptake/penetration	10%	30%	16%	39%
FIQ users			1,400	3,500+
Total S&B farmers			9,000	9,000
Weight gain				
Lamb (g/day)	250	300	370	320
Beef cattle (g/day)	800	1000	900	700
Deer (g/day)	Not considered	Not considered	200	200
Weaning %				
Lambing	140%	150%	125%	140%
Calving	85%	90%	85%	88%
Fawning	Not considered	Not considered	85%	90%
Branded product price				
Lamb ($/kg)	14.10	14.10	None	None
Beef ($/kg)	7.81	7.81	None	None
Branded %	Not shown	Not shown	None	None
Marketing incremental EBITDA	$26m	$133m		
Value add sales			$74m	$200m

Notes: EBITDA – earnings before income tax, depreciation and amortisation.

3. While FarmIQ farm productivity may be lower than Cranleigh, higher software uptake compensates for this lag.
4. While marketing value chain gains are unclear from FarmIQ, Cranleigh sensitivity analysis showed that higher uptake (from 30% to 40%) adds $141m to farm productivity gain. This more than offsets any underachievement of the $133m marketing value chain gain.
5. Potential adoption of FarmIQ by dairy farmers provides a new source of value chain gains.

Overall lessons that can be drawn in assessing FarmIQ's achievement of milestones and key programme indicators are:

1. The imperative to have a simple one-page summary of key performance indicators that can consistently and readily be measured across time. This is a challenge, but achievable if one indicator per IO is chosen
2. Key performance indicators are logically linked and readily traceable to the national level economic benefit target.

4.4 Anticipation of impacts of external changes

FarmIQ management's view is that a number of impacts were not easy to predict including: the Global Financial Crisis fall out (not a good time for launching premium products); PGW's financial difficulties precipitating its exit from FarmIQ; the sharp commodity price fall leading to in market contracts being removed e.g. McDonald and Tesco; SFF financial challenges which led to it seeking and gaining a new majority shareholder; and the launch of Landcorp' s Pamu brand (which is perceived by some as competing with Silver Fern Farms). These factors set back FarmIQ's progress. Nevertheless, FarmIQ navigated these challenges as they arose. Without PGP, FarmIQ initiatives – software, genomics, market feedback and eating quality research - would not have happened as a package as the risks for an individual company were too high.

In hind sight, maybe a different strategy centred on getting to market sooner with a simplified software product aimed to directly support the value chain instead of trying to perfect a suite of products would have been preferable. Also, working at the beginning with a small number of mostly above average farmers as the pilot has been criticised. Despite these challenges, the software programme is on track to exceed the current target outcomes.

4.4.1 Investment partners with MPI

The process of preparing the business case and proposal to MPI took 18 months. FarmIQ was formed out of SFF and PGW. When PGW struck financial trouble FarmIQ was seen as non-strategic and the board decided not to invest. A similar exercise meant LIC went at an earlier stage but has since kept an interest and is not seen as a competitor with FarmIQ for sheep and beef cattle farmers at least. Before the business case was finalised Landcorp came on board. Together SFF and Landcorp have since been the mainstays of the programme. VetEnt bought in later to FarmIQ Systems Ltd to provide a productivity edge for their clients. The expected in-house wider client base for FarmIQ software did not eventuate as planned once PGW exited but the buy-in by Farmlands Co-operative in late 2017 will help to remedy this by bringing market leading technology to its 66,000 shareholders.

A key driver for SFF was the need to obtain technology that would give it a "back to back" relationship with farmers and customers. This was needed to facilitate on-farm inventory control so that promises to SFF customers could be honoured through beef and lamb supply contracts with farmers. This was seen as providing the evidence to meet regulatory requirements and to back up

the New Zealand value chain story. The involvement of high performing farmers in the development of FarmIQ meant that on-farm performance became part of the programme, which during the business case development was implied rather than made explicit. The original hypothesis was that farmers would not have to pay for FarmIQ software. It would be used as evidence for "story telling" and as a tool to manage stock to processing and be a black box inside SFF. This had to change after PGW withdrew. When SFF and PGW were about to integrate, they would have controlled about 50% of livestock and there would have been enough value created for farmers not needing to pay. Now that two new B2B partners have come on board, FarmIQ Systems Ltd is back to the original concept.

4.4.2 External environment, collaboration and competition

Smart phones and broadband internet access have changed the digital landscape for farmers. When the FarmIQ programme started few farmers had smart phones and broadband internet access was limited. In this sense FarmIQ software was five years too early. The Global Financial Crisis and governance issues compounded the difficulties of achieving adoption rate targets.

FarmIQ was one of the first PGP programmes to get off the ground. In the early days politics around the first mover advantage caused friction across the industry. This has now dissipated and a more collaborative environment exists. Several of the Red Meat Profit Partnership (RMPP) projects, such as farm data standards and farm extension initiatives, will leverage FarmIQ.

The Massey University Stocktake of Farm Management Apps used by Farmers and Rural Professionals (Hammond, 2012), found over a two month period (March-May 2012), 59 agricultural specific apps. Much has changed over the last five years. AgriOne provides a library of software tools and apps for farmers. On their website (AgriOne 2017) 415 such tools/apps are listed. AgriOne, set up in 2012 by Lincoln and Massey Universities as part of the Transforming Dairy Value Chain PGP programme, was established to lift the collaborative responsive to industry requirements. A core focus was improving the integration between the universities agricultural programmes for the Agri-Food industry. This was achieved through education programmes and projects such as the Centre of Excellence in Farm Business Management (CEFBM). We note AgriOne is in the process of folding up as PGP funding has ceased and the two universities do not have the commitment to continue to jointly operate the venture. Other providers such as CEFBM are now taking over the outputs.

AgriGate is the nearest to what FarmIQ does, but at this stage is limited to tracking milk flow, dairy cow management and some financials. FarmIQ and AgriGate cross-over for some aspects of animal recording, but AgriGate does not cover most of land and none of the people aspect of farming.

The RMPP software DataLinker (RMPP 2016b) is a critical component of the FarmIQ solution as it allows the sharing of data from different sources. This is a key complementarity between FarmIQ and RMPP.

The FarmIQ Systems business was separated from the programme in May 2016 and has made rapid progress since. To stay relevant FarmIQ Systems Ltd is pursuing a strategy to engage customers, empower employees, optimise operations and transform products, with the catch phrase "perform as you transform" meaning "work smarter not harder" and utilise machine learning. The effectiveness of this strategy is shown by subscription growth and fewer farmers leaving the programme (now less than 4% and annual churn less than 2%). Management believe new technology like blockchain is still some time off. Fonterra uses blockchain for its vat to market value chain, but has not extended this back to the farm. FarmIQ Systems management believe their first mover advantage gives them a strong market position.

At this stage FarmIQ Systems Ltd's potential competitors cannot provide the level of functionality across applications in real time and with remote verification. In this respect, FarmIQ software can be a catalyst and enabler for existing and new apps for others. For example, FarmIQ has developed on-line tools for Beef +Lamb NZ to estimate meat yield (red meat kg/ha) and live weight gain for lamb (kg/ha).

4.5 Effectiveness of programme governance

While the governance structure was flexible enough to cope with changes in investment partners other lessons have been learned.

As an early stage large PGP investment, FarmIQ's governance structure was impacted by MPI's caution over potential liability and navigating the Public Finance Act. The MBIE standard operating model was applied. FRST was the lead manager of the PGP. MPI acted as the Secretariat with service contracts to FRST. The key issue was whether FarmIQ was delivering on the plan. MPI was not represented on the FarmIQ Board, did not attend Board meetings and was only brought into discussions after Board meetings had finished and the PSG convened. At times MPI felt left out of the loop and not able to influence decisions, even though the PSG had the same level of reporting as the FarmIQ Board and any outcomes from the FarmIQ Board were reported to the MPI Rep as a minimum. In contrast, as a more recently established PGP programme, the RMPP has full transparency where the Board and the PSG are effectively "one" except for staff issues which are a matter for the Board alone. A key learning MPI has taken up is to clearly state at each stage of the programme what their expectations/requirements are in terms of presence on any new entities born out of the PGP programmes.

Over time MPI's approach to PGP governance gradually transitioned from a grant model to an investment model where the focus is on outcomes. Initial MPI staff were policy analysts whereas now they are investment managers. This was achieved over three phases. After contract signing it was clear more transparency was required which led to the Outcomes Logic Model (OLM) and more public reporting via the web site. The third and current investment phase came in about three years ago. Whereas at contract negotiation MPI's emphasis was on funding to the programme now the emphasis is on an investment to get outcomes. Users are the proxy for increased on-farm productivity, under pinned by value add sales leading to the target of $1.2 billion increase in gross output by 2022. Each year the contract has been reviewed and amended via Variations, which become the operational contract. The key document is the OLM with the Measures Table or benefit map in behind it. A helpful learning was the introduction of a new independent Board Chair to FarmIQ Systems Ltd, and towards the end of the programme MPI was invited to attend some FarmIQ Board meetings as an observer.

The FarmIQ Board and management must take some responsibility for the situation at the end of 2016 where MPI was close to withdrawing funding for the Data and IT element of the programme. Early concerns over a lack of progress on uptake of the farm management system were expressed by the IAP. By August 2016 it did not look like FarmIQ software would make the new targets (30% uptake by 2025). Moreover, it did not look like the revenue would be there to be self-sustaining. The IAP wanted to be reassured on subscriber numbers and that the capital base was secured. MPI undertook work to understand why uptake was so slow (see section 3.1 for a discussion on informational technology uptake).

FarmIQ had earlier started a restructuring of the entities delivering the FarmIQ Programme and renewed efforts to secure a new shareholder. The result was the establishment of a new company,

FarmIQ Systems Limited, in May 2016 with an independent commercial Board and a clear mandate to drive sales to increase subscriptions to the programme target (and a level that would sustain financial viability) and introduce new shareholders (and capital). VetEnt was the first new investor to come on board. User numbers started to grow strongly. At the time of writing FarmIQ Systems Limited is confident the capital needed to get through to positive cash flow by 2022 will be in place.

MPI is agnostic as to whether productivity gains come from within FarmIQ or from other initiatives as long as the gains come about.

As evaluators, we have struggled to find quantitative indicators recorded on a consistent annual basis to demonstrate progress against the Schedule 7 objective achievement measures. In the multitude of detail presented, the key performance measures which should be summarised down to a single page have been lost. Responsibility for ensuring regular reporting on simple quantitative indicators must lie with the PSG. It should be a priority to ensure such reporting occurs.

5 LESSONS LEARNED

5.1 Main lessons

We agree with FarmIQ management's six main learnings from the programme:

- The overall budget envelope was originally set 9 years ago. MPI have been very flexible so long as the programme stayed within overall budget. This was critical to the success of the programme.
- Having the right foundation partners in larger, longer term programmes is critical. The partners need to be able to go the distance.
- MPI investment kept all parties on the same 'page' the majority of the time.
- Science is relatively simple compared with changing human behaviour.
- MPI could be more effective in promoting collaboration across programmes (e.g. FarmIQ and RMPP) and making this a contractual obligation.
- Having two boards – commercial and PSG does work so long as there is common management, director overlap and alignment of objectives.

Several interviewees drew attention to the large size of the FarmIQ PGP programme and the need for smaller more flexible and quicker footed programmes. Given this feedback and the knowledge that the PGP minimum size is a total industry investment of $500,000 plus MPI contribution spread over 7 years with a 60:40 industry/MPI split, MPI need to do more to make this information more widely known.

MPI has learned from the FarmIQ experience particularly around the motivation of industry participants and how this affects public good outcomes while ensuring industry participants secure first mover advantage and an investment return. SFF were looking for first-mover advantage over its industry rivals to increase returns to shareholders through advances in value chain management. Landcorp needed to demonstrate that its scale offered a return to the government by increasing productivity and moving along the value chain into value added branded products (Pamu), thus in some respects becoming a competitor to SFF.

Adaptability and agility are important attributes in PGP programme delivery and MPI must continue to facilitate increased proficiency in this.

Commercial drivers and exit pathways should be clearly set out in the business plan and shape programme inception – a key learning now taken up by MPI. This will provide clarity on how commercialisation of outputs can be achieved early and ensure a strong focus is kept in building a compelling value proposition for farmers based on meeting on-farm needs (farmer pull) rather than technology push. This commercial view can sometimes run counter to that of the public sector which subscribes to driving progress from an overall vision and the generation of new knowledge and ongoing research. Our view sides with the commercial approach – market led and fast fail – and PGP programmes with their industry-led approach operate in this frame too. It is a key point in programme evaluation pre-investment and a major learning from the programme.

The early versions of FarmIQ software were too complex even though the design was informed by farmer input/feedback and the vision. On-farm software requires simplicity of use and automated (preferably in field) data entry. The advent of mobile devices has enabled this.

Stretch science such as genomics in FarmIQ's case, is an important element in building programme impact, but will generally require a strong commitment from programme partners post-MPI investment to see the full benefits realised. For FarmIQ it is vital Silver Fern Farm works to close the

feedback loop to farmers via EID and sustain a high-quality working relationship with BLG to get the full benefits from genomic assisted breeding plans. This is important because the main payback on the FarmIQ investment (70%) will come from increased farm productivity (better management decisions, enduring genetic feed conversion efficiency and product attributes). FarmIQ adds significant value to BLG's work.

Greater gains could have been made if Silver Fern Farms had worked more openly and co-operatively with other meat companies from programme inception (i.e. a NZ Inc approach). In this respect it is pleasing that there are regular catch-ups to review extension practices and learnings within the PGP network (including RMPP, Clearview Innovations, FarmIQ, Marbled Grass Fed Beef, Pioneering to Precision, and Spring Sheep Milk Co). However, it was apparent from interviewee comments that more effort needs to be made by MPI and PGP participants to effectively communicate information about the PGP network collaboration to the senior echelons of the companies involved in the programmes.

To track programme delivery, MPI should insist on the PSG getting the programme KPIs clear and distilled onto a one-page dashboard and manage these by exception. Part of this will be to measure progress against a clearly quantifiable counterfactual so that actual programme gains can be realistically evaluated. A one-page dashboard will also facilitate improved communication on KPI progress with the Investment Advisory Panel (IAP).

5.1.1 Commercial arrangements to ensure FarmIQ Systems Ltd achieves commercial sustainability in the near future:

- Dilute SFF shareholding (from 75%) through the introduction of one or more new shareholders who see ways to grow FMS's value and enhanced market penetration.
- Increase FarmIQ capital, board skill sets/networks, phone app enabled tools with much increased inter-operability
- Extend underwriting beyond 2018 as FMS projections indicate they will need cash injections till 2020
- Further adjust the balance of FMS Director skills to include better capacity to build a bridge to Fonterra-LIC's AgriGate and better align with the RMPP
- Create a sharper more compelling farm value proposition for the next 50% of slower adopter, 40-65 year old single person operators
- Demonstrate time and cost savings over competitors in the highly contested spaces around compliance for H&S, staff management and environmental planning
- Not overlook the meat quality-genetics value potential opportunity as the cost of EID tags for sheep decreases.

5.1.2 Main payback on the investment:

- The main payback is farm productivity (70%).
- FarmIQ uptake results in capital investment, board skill sets/networks, phone apps, much increased inter-operability
- EID tags to close the 'genetics' loop and increase focus on efficiency.

5.2 Implications for PGP of lessons, benefits, risks, value-chain, sectors and future strategy

Maintaining a value chain focus, or at least linkage remains important. MPI fully understands industry-led research and development undertaken in isolation from the market or productive base is risky and accordingly does not fund such work.

Utilising investment to collaboratively create change in/across sectors can be more beneficial than a single sector approach, and perhaps industry could propose PGP programmes with stronger cross-sector collaboration. Although we note the FarmIQ programme, despite several endeavours, found it difficult to engage with the dairy sector regarding the use of its farm management software.

The PGP programmes are based on a business hypothesis rather than a business case as such. Thus, you may or may not get what you planned. In particular, behaviour change along a value chain takes significantly longer unless the rewards or penalties are significant.

Government programmes like the PGP offer MPI the opportunity to engage closely with sectors and, in some situations, act as a sector facilitator to bring parties together or highlight areas not yet developed. This requires MPI staff to have the right mix of commercial, technical, facilitation and governance skills and experience.

Information technology is advancing exponentially so trying to plan in detail seven years in advance is futile. Whatever is planned is likely to be disrupted. The learning is to stay small and flexible, and enable agility via programme variations.

Findings from the FarmIQ evaluation confirm the need to develop technology and systems to produce premium quality beef from animals sourced from dairy herds. We note this would also help to achieve 'bobby free dairy'. This requires high intra-muscular fat breeds such as Wagyu which are the focus of the Marbled Grass-fed Beef PGP programme[17]. The programme is seeking to develop an integrated value chain for high-value, marbled beef (especially from Wagyu-dairy crossbreeds) that is internationally recognised for its superior eating qualities. Done well this will reduce the exposure of dairy farming to animal welfare claims. All meat companies need increased supply (and improved genetics for beef products) from dairy herds. This initiative could help to reduce the present procurement vs quality tension and adds positively to a "NZ Inc Story" that keeps New Zealand access to high margin red meat export markets and the growing tourist market in New Zealand.

6 CONCLUSIONS

We expect FarmIQ to make a positive return on investment. FarmIQ has already enabled enduring change within Silver Fern Farms that *all things being equal* will support ongoing value add product development and improved market feedback to farmers.

The work of Beef+Lamb Genetics and its desire to link with FarmIQ software to access phenotypic information from commercial flocks and herds is very important. It will secure the potential gains from improved breeding plans for eating quality and the application of marker-assisted selection (MAS) to accelerate genetic gains in flocks and herds.

[17] Information about this PGP programme is available at: https://mpi.govt.nz/funding-and-programmes/primary-growth-partnership/primary-growth-partnership-programmes/marbled-grass-fed-beef/"gt;Marbled

The caveats to FarmIQ Management Systems software reaching its potential are: a more compelling value proposition for the next 30 – 40% of farmers; the B2B strategy to work; increased collaboration among IT providers; continuing transformation while delivering; more effort by meat companies to support faster, enduring gains from genomics; and ongoing extension of ultra-fast broadband into remote rural districts.

Future government investment in agri-sector IT should be promoted at the small and flexible level.

The FarmIQ PGP programme provides valuable lessons, as identified in this report, to enhance benefits from other PGP programmes in play, and to assist the design and evaluation of future PGP programmes so that the risk of the Crown not achieving a satisfactory return on funds invested is low.

7 Appendix I. References

Agri One 2017. Software library of agribusiness tools and apps. http://www.agrione.ac.nz/apps-and-software

Beef+Lamb Genetics 2017. Land and Environment Plans. http://www.beeflambnz.com/LEP

Cranleigh 2016. FarmIQ Strategic Review, Profitability Gains Generated by FarmIQ, July 2016.

Cooke, Andrew 2017. On farm recording tools, Beef+Lamb Genetics http://www.blnzgenetics.com/files/1469704165_Rezare%20BLG%20Breeders%20Forum%20Workshop%202016-07-12.pdf

FarmIQ 2017. I've got other farm management software, where does the FarmIQ System fit? Down loaded 17.8.17. https://www.farmiq.co.nz/farm-management-software/faq#125

Ismail, S., M. Malone and Y. van Geest 2014. Exponential Organizations. Why new organisations are ten times better, faster and cheaper than yours (and what to do about it). Diversion Books, New York.

NZIER 2014. Decomposition of estimated impacts from PGP projects. COMMERCIAL IN CONFIDENCE Appendix to final report, NZIER report to Ministry for Primary Industries, May 2014.

NZIER 2017. Evaluation of FarmIQ, NZIER report to Farm IQ, May 2017.

RMPP 2015. RMPP Research Summary Overview December 2015. UMR Research. http://www.rmpp.co.nz/site_files/13089/upload_files/RMPPSegmentationResearchSummaryDec2015.pdf?dl=1

RMPP 2016a. Red Meat Profit Partnership study gathers vital data to help boost productivity in sector. http://www.rmpp.co.nz/page/8-april-2016/

RMPP 2016b. RMPP: DataLinker, eASD and Benchmarking, Michael Smith and Mark Johnstone, from the Red Meat Profit Partnership, present at Beef + Lamb New Zealand's AgInnovation 2016 conference. http://www.beeflambnz.com/knowledge-hub/video/rmpp-datalinker-easd-and-benchmarking

8 Appendix II. Evaluation Questions

1. OUTCOMES: What has been achieved by the programme and what are the benefits of the programme to New Zealand?

a. Did MPI and the FarmIQ partners get what they expected from the investment in the PGP programme – as set out in the original business case and amended by subsequent annual plans?
b. Has the investment been worthwhile?
c. Has the programme achieved the expected short term outcomes identified in the original outcome logic model?
d. To what extent has the programme led to building human capability-capacity?
e. Has the programme made sufficient progress on the commercialisation of an integrated value chain for the red meat sector?
f. Are the expected economic benefits and other intended medium and long term outcomes listed in the Final Report realistic and achievable?
g. Did/Will the programme create spill over benefits and opportunities for other parties directly or indirectly?
h. Have there been any unintended outcomes or consequences (good or bad)?

2. **EXECUTION**:
a. Did the programme engage the right level of expertise to address the science and marketing and other challenges?
b. Were the programme's structure, systems and management effective?
c. How well did the programme do in achieving its milestones and achievement measures?
d. Were there any external changes that impacted on the programme? Were these anticipated, or could they have reasonably been anticipated, at the start of the programme?
e. How effective was the programme's governance?

3. **LESSONS LEARNED**
a. What were the main lessons from the programme? In particular, lessons from the findings on the programme's outcomes and its execution.
b. What are the implications, if any, for the PGP in terms of lessons, benefits, risks, value chains, sectors and future strategy in this area?