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What Value do Commercial Farmers Place on their Animal Genetics?

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To the reader – I hope you enjoy reading this and will help me to spread the word about genetics!

Please don't hesitate to contact me with any questions or comments that you may have. There is so much more to learn, so let's do it!

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Executive Summary

New Zealand's animal genetics industry started when two sheep were imported, and they both died within four days, (NZ Rural Press Ltd, 2007). Since then, with the expertise of passionate breeders, scientists, farmers and advisers it is has significantly expanded and will continue to do so. By 2021, animal genetics is expected to be a USA$5.50 billion dollar industry, (PRNewswire, 2016). International markets especially, are taking advantages of the incredible advances in genetic technologies that enable increased efficiency in breeding genetically superior animals. In New Zealand, we must take advantage of the genetically superior stud stock that have been especially bred for our environment to allow farmers and the industry as a whole, to reach our production targets but do so in a sustainable way and with 'value add'. To do this, we must insure that the 'value' of genetics is recognised by our New Zealand farmers as a significant player in the agricultural system.

The question was asked "is there a gap in the understanding of farmers, when it comes to their animal genetics?" and the answer was yes. This research attempts to understand why there is this gap by interviewing farmers, industry professionals and advisers. Farmer behaviour has been aligned with answers to the interviews and both the livestock in New Zealand, and New Zealand farmers have been described under the concept that their performance is a function of their genotype, or their goals and objectives, and the environment that they live in.

There is a range of performance of New Zealand farmers in their farm systems overall, but also in their understanding when it comes to genetics. Some reasons for this are more obvious, like the fact that you can't "see" genetics, which makes it difficult to comprehend, or the fact that there is actually no pipeline for delivering simple and aligned genetic information out to the commercial sector. The not so obvious reasons can be understood by further analysing the goals and objectives of farmers, but also the social pressures that they face when striving to be a 'good' farmer. An animal is more likely to be judged by the way it looks, compared to its genetic potential, which will be a direct indication of how good of a farmer the owner is.

Recommendations have been made to the industry, to the advisers and to the farmers. There needs to be collaboration across the genetics "players" to provide breeders **and** commercial farmers with quality information that is transparent and has integrity. Farmer objectives need to be better understood, so solutions can be tailored and aligned. Both farmers and their advisers need to be more critically aware about animal genetics, in terms of what they are buying and where they are buying it from. The story of animal genetics needs to be told and it is performance that needs to be made trendy.

In order to understand, and appreciate the value of their livestock genetics, commercial farmers need to be individually understood, and they need to be empowered with the information to make a decision, which fits their individual objective.

Introduction:

Livestock production systems globally are appreciating genetics and its influence on production as a tool for making significant improvement. The animal genetics market is expected to grow significantly over the next 5 years. The genetic potential of animals is increasingly being researched and new levels of animal performance are being unlocked.

Animal genetics is not generally something that can be visualised, so therefore making it difficult to comprehend. However understanding how the genetics of an animal can influence production, is vital for improving performance. For New Zealand, continual improvement in livestock production is essential if we are to maintain our red meat export position, supply the market with a 'value add' product and sustainably double our exports by 2025. To do this successfully, animal genetics must be recognised as a significant contributor in our unique New Zealand story of pasture to plate.

The objective of my Kellogg project is to gain a better understanding of the value New Zealand farmers place on animal genetics. I suspect that there is a significant gap in the understanding of genetics and I would dearly like to know why.

I am involved in disseminating education, knowledge and understanding of the application and use of DNA technology in New Zealand's Beef and Sheep industry's. I have come to appreciate that farming is traditional and relatively conservative for many wonderful reasons, both industrial and social. However I am concerned that the lack adoption of more modern forms of farming tools and technologies is stifling the sector and is increasingly becoming an issue. I have tried to understand via qualitative and quantitative methods, through 'over the fence' anecdotal notes, what New Zealand farmers need, to understand the value of their livestock's genetic potential.

In attempting to gain this knowledge I have personally interviewed sheep and beef farmers, industry advisers and sheep and beef breeders from across the sector. I developed a short survey and delivered this via social media platforms where I was fortunate enough to receive 155 responses. I have concluded that there is indeed a gap in farmer understanding of genetics. This presents a lost opportunity to the industry and having identified it, we should exploit it. In this report I have tried to dissect some of the reasons why and perhaps more importantly what steps we might put in place to rectify the situation.

In addition to surveying farmers and industry leaders, I have completed a concise literature review in areas of farmer behaviour. Understanding the characteristics of farmers has helped me describe the Phenotype of 'farmers' which in turn might help you the reader understand how the gap in farmer knowledge about genetics has evolved.

I believe that most farmers are continually looking for ways to improve. Like any industry, there is a section of farmers who do not improve but as demonstrated by production statistics of previous decades, these farmers are in a minority and

they do not diminish the significant gains made by most progressive farmers. New Zealand farmers are generally owner operators and make many important decisions daily. They are the primary decision makers for their farming system and they carry significant levels of risk with every decision. Mitigating this risk is reliant on good information and the resounding message I have clearly received is that, good information is hard to come by. In fact some respondents have been more specific and suggested that information is simply hard to comprehend. Farmers want easily accessible, simple tools that help them make their own decisions about what rams or bulls they should be buying, or what breeder they should be buying them from. They want knowledge about breeders that they can compare on a level playing field. To improve requires knowledge. Farmer knowledge is gained from many different sources but most commonly from other farmers and their experience. However it proves difficult to unravel knowledge if the *true* message is not obvious, and talked about often.

A critical thinking process is something that I think farmers could benefit from. There is an unfortunate level of 'acceptance' when it comes to key decisions about genetics. The quotation "the way my grandfather did it" has become a sad reflection on some aspects of farming especially considering the wave of automation and artificial intelligence that is supposed to impact industry globally. Farmers need to be more confident in asking many questions of their ram and bull breeders and have a firm grip on what their farming objective is to understand whether it aligns with that of their breeder. Advisers also need to be more aware of farmer behaviour and needs so they can provide better support; providing information, not just data.

If the goal on farm is to sustainably increase production, add value to the end-product, reduce the environmental footprint, maintain healthy stock or ALL of the above, then we need to make performance orientated farming trendy – talking about it simply, with integrity, and more often.

Aims and Objectives

I am fully aware of the part that genetics plays in the farming system. I have a full appreciation of the fact that genetics is not the only aspect to be considered, and that feeding and management of stock is also critical to the success of an enterprise. Farming is about the whole agricultural system, and this has not been forgotten. However, I have chosen to look at just one aspect - genetics.

I see a variety of breeders that all have differing breeding objectives. Those that are breeding for a specific trait, those that are breeding for a balance of the economic traits, those that are focussed on structure and conformation, and those that are not really sure of what their breeding objective is. I hear of breeders that are marketing their stud stock according to their objectives. I also hear of breeders marketing breeding objectives that are far from what is apparent in their genetic trends.

I have looked at many genetic trend graphs where genetic progress is improving rapidly. I have looked at many genetic trend graphs that have had limited progress and are below the industry average for particular traits, or have a combination of traits. I have also seen genetic trend graphs that have had a drastic change in a trait, due to an obvious change in attitude towards that trait.

I have worked with breeders who are actively seeking new ideas, technologies and advice to keep improving the genetic quality of their stock, year on year. I have noticed breeders who are doing what they have always done and getting the performance that they have always got.

I feel the frustration of many breeders when rams or bulls are bought that are 'home bred' and therefore are genetically inferior in comparison to those bred in a fully recorded stud where all the recording methods and technologies have been utilised.

I hear academics describe the value of genetics and emphasising the higher profitability of buying a more expensive and more genetically superior ram/bull. I also hear that a farmer's investment in genetics is usually the fist thing to be cut, in a hard year.

I personally am frustrated when I read the farming magazines and there is very limited mention of genetics. I read articles where I am aware of the genetic potential of the ram or bulls that have been purchased but nothing has been mentioned about genetics as being a factor to their success. I am blown away when I learn of a farming system that has not even considered the impact of how their livestock performance could be enhanced simply by buying better genetics. I am frustrated when I hear myths about livestock success being 90% about breeding and 10% about the genetics. I am frustrated when I hear advice from industry professionals about genetics, which are non-factual and just blatantly not true. I am frustrated when I only hear talk about the outside appearance of stock, and not about their actual performance in terms of fertility or growth.

So much progress could be made if genetics was considered as a vital tool in the commercial farmer's toolbox.

For my project I wanted to validate my belief that the majority of commercial farmers do not understand the impact that superior genetics can have on their overall farm productivity and profitability.

I have identified four questions to research and draw conclusions on.

- Is there a gap in commercial farmer understanding of genetics?
- Why is there this gap?
- Is this an issue?
- What is the solution?

Literature Review

When the first shipment of sheep, (one ram and one ewe), came into New Zealand, they both died within four days. They just were not fit for the New Zealand environment, (NZ Rural Press Ltd, 2007). After a few more attempts, it was soon identified that the Merino breed already established on Australia, was actually a good fit for the vastly clearing landscape in New Zealand. Merinos were known for their wool and the money that could be made from selling it to local and international markets. In the early days, the carcass was seen as a bi product because there was no way to preserve, what the locals couldn't eat in the short amount of time they had before it expired. Once there was an identified market for mutton abroad and a way to get it there as a fresh carcass, there was a whole new reason to produce sheep. The meat trade had been established. Merinos were crossed with the Border Leister that bought that meat element and combined with wool meant two streams of income. The Romney soon became the most popular breed in New Zealand and still is to this day - a dual-purpose breed that had valuable traits for meat and wool production, along with traits giving it the ability to survive, produce and flourish in the harsh New Zealand climate. Within the Romney breed, we have also seen a variation in size. The carcass needed to be small and contained for shipping purposes and other traits, such as having an open face which was much more practical for the New Zealand Hill country. Whether they realised it or not, the early settlers of New Zealand had a knowledge of genetics and how it could be manipulated to suit the New Zealand environment, to suit the profits of the producers and to suit the changing preferences of the consumer market. (NZ Rural Press Ltd, 2007)

It was within breed variation that was exploited by the Advanced Romney Designer Genetics group (ARDG) when they produced a flock of Romney sheep that had significant tolerance to facial eczema (FE). FE is a metabolic disease that has caused substantial loss in animal production in New Zealand since the severe outbreak in 1935, right up to this 2016 season that has had comparable severity, (NC Amyes, 2014). The success of breeding for FE tolerance, demonstrated by the ARDG group and other groups who followed, is an excellent example of breeders and scientists coming together to solve an industry issue with genetics. Over 29 years, the ARDG group has seen a 2% increase per year in FE tolerance, which is directly attributed to the recording, monitoring and enhancing of genetics. Advances in technology are now providing even more opportunity for ARDG in this area, (ARDG, 2016)

Scientists and sheep breeders have devoted their time and efforts into understanding the genetic component of production and the above is only one of many examples where significant success has been comprehended and has been beneficial to the whole industry. Genetic improvement was taken to the next level when New Zealand's own genetic evaluation system, which is among the most advanced in the world, was launched in 1999 and is called, Sheep Improvement Limited (SIL), (Cruickshank, 2003). SIL has played a critical role in the genetic improvement of the New Zealand flock by allowing a means for the provision of consistent, accurate and relevant genetic information to sheep performance breeders.

"Once SIL was introduced in New Zealand, the rates of genetic gain doubled", (M. Young, 2008).

A concept that has been defined by SIL is as follows,

"The performance and physical appearance of an organism is otherwise known as the Phenotype. The phenotype can be attributed to the genes that have been inherited from the previous generations, and the environmental or management circumstances that they are exposed to" (Sheep Improvement Limited)

A simple equation of this concept is the below:

$$P = G + E$$

Phenotype = the Genotype + the Environment

Phenotype (P): The physical appearance, and performance of sheep. How big they are, what colour they are, how well they grow, how many lambs they have, how healthy they are, their ability to walk up and down the hill country of New Zealand. *The "type" of sheep.*

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Genotype (G): What has been passed onto an animal over many generations, through the genes.

Environment (E): The conditions an animal has been managed in, the weather patterns in a particular season or over a particular time, the amount and quality of feed consumed, the birth rank (twin vs. single), when an animal is born (early or late).

Realising that there are two elements to consider in the performance of livestock, genotype and the environment, Beef and Lamb Genetics (BLG) has been established with a focus on genetics. BLG (a subsidiary of Beef and Lamb New Zealand), are committed to New Zealand Sheep and Beef farmers providing tools, education and research into the genetic side of production. (Beef and Lamb Genetics, 2015). Because of the accumulative impacts of BLG and their former entities, we have seen over time that genetics alone has added an extra $7.50-$8 of value per ewe mated. By 2025, BLG expects their further developments in genetic tools and technologies to further increase this value to $20 per ewe. The current value has been quantified by producing more lambs per ewe, and heavier lamb carcasses, (M. Young, 2008).

In relatively recent years, the use of breeding values from genetic evaluation systems (i.e. SIL) has attempted to provide a basis for benchmarking for breeders and their animals. It was noted in a BLG research and development paper recently, that breeders have been consistently improving their knowledge and awareness of the implications that genetics have on their stock, *however*

commercial farmers are not yet as equally informed. (Beef and Lamb Genetics, 2015) . It has been suggested that 90% of bull and ram purchases are made from breeders who have at their disposal, genetic evaluation system information. However only 30% of rams purchased are thought to be made using this breeding value information. In the Red Meat Sector strategy report, genetics is mentioned as an improvement that top performing farmers are focussed on, along with improvements in pasture management, farming practices and business skills, (B+LNZ, MIA, 2011). From this, it seems there is a gap in knowledge of the commercial farmer sector.

"The main determinant of genetic improvement is in the decision of commercial ram buyers to seek the best available genetics" (Cruickshank, 2003). For this reason BLG are right now being involved in extension of genetic concepts across the industry. Just one example is the "Data Drives Dollars" trial that was undertaken last year. The aim of this trial was to prove to commercial farmers that genetics, do work, that breeding values, do work. From the trial it was shown that by buying rams with a higher genetic merit meant lambs could be produced that were close to 1kg heavier at weaning, resulting in $1.69 more per lamb, (Genetics, 2016)

According to the latest market research, the global animal genetics market is expected to keep growing 'tremendously' to become a USA$5.50 billion industry by 2021, (PRNewswire, 2016). The rising demand for animal protein by consumers and accumulative increases in the global population are just two factors that are contributing to this growth. International markets especially, are taking advantages of the incredible advances in genetic technologies that enable increased efficiency in breeding genetically superior animals. Artificial insemination (AI), Embryo transfer (ET) and DNA technologies such as single marker gene tests and genomics are all utilised, (to varying extents) in New Zealand to speed up genetic gain and take production to the next level. MyoMAX is an individual gene (that can be tested for), which is known to consistently increase a lamb's carcass weight and muscle yield. If a lamb is carrying 2 copies of this gene it will produce 10% more muscling, and 14% less carcass fat, (Zoetis New Zealand, 2016).

Genomics is the ability to predict an animal's future performance from its DNA, (Liebergreen, Keeping up with constant change, 2016). "A particular New Zealand ram breeder is investing in genomics to increase the accuracy of ram selections for his own flock. He is currently spending $13000 per year on this, genomic, DNA tool. From doing this, he has produced $126 000 worth of better genetics, as rams sold. DNA technology if fully utilised and understood, has the potential to change the industry" (Liebergreen, Technology and Extension Manager, B+LNZ Genetics, 2016)

Both America and Australia have moved to yield based payment now NZ is following suit with one meat processor in general. A premium is paid to farmers who can produce a higher value carcass. As NZ moves into the 'value add' market, it must be realised the impact that genetics can have on adding value. The Omega Lamb Project is a prime New Zealand example where the whole

agricultural system is considered, in "producing the worlds tastiest lamb with high levels of health-giving Omega-3 fats and oils" while also providing a premium back to farmers. (Gray, 2016)

In analysing the above literature, I hope it is as obvious to the reader, as it is to me, that not only does genetics play a vital role in the performance of an individual animal, but also in the overall performance of the agriculture sector. However, the understanding by commercial farmers of this concept is the key driver to further industry opportunity and the literature already hints that there is a gap in knowledge which suggests that this opportunity is not being maximised. In this project I want to combine my learnings from the above literature, my prior knowledge of genetics, and the results from my research. I then want to dig deeper into farmer behaviour to help me further understand the concept of animal genetics, from the commercial farmers' perspective.

I am going to use SIL's concept of Phenotype, to organise my readings from the literature on farmer behaviour to make associations about farmer performance and what the contributing factors are.

$$P = G + E$$

Phenotype = the Genotype + the Environment

Farmer decision-making, performance and what he/she produces is a function of his/her values, goals and objectives that have been inherited through past generations and also the environment that is farmed in. Social scientist and psychologist Kurt Lewin said that 'behaviour is a function of a person in their environment' (Gasson, 1973).

Phenotype (P): The physical appearance and performance of farmers. The decisions they make based on their individual objectives, values attitudes and ability to think critically. The farmers' ability to judge a situation and his reaction. The farmers' likeliness to try new things and take risks. *The 'type' of farmer.*

Genotype (G): "Farming is in the genes", "you are either born with the stock sense, or not". "The ability to be a Farmer is a 'gift' that is passed on through the generations". Farming is 'bred' into a person through relationships, experiences and social conditioning in the same way that sheep are bred for the conditions on the hillsides". The goals and objectives that have been passed down through generations.

Environment (E): The changeable and unpredictable climate i.e.: price schedule at any given time, the social environment, attitudes of the general public towards farmers, attitudes of farmers, towards other farmers. Farmers being highly influenced by other farmers.

Farmer Genotype – Values, Goals and Objectives

Farmer goals and objectives may change depending on age and stage of life; however values are a more permanent property of the individual, (Fairweather, 1994). I am linking this concept with the genotype that is also permanent property of an individual. There is much research into the goals, values and objectives of farmers. Fairweathers work was something that resonated with me as it put New Zealand farmers into three management styles - the dedicated producer, the flexible strategist and the environmentalist (Fairweather, 1994)

1. **The Dedicated Producer**

The ultimate outcome for the dedicated producer is to become the best possible farmer, measured by producing the best quality product and being financially viable. To do this he/she is totally committed to farm work, planning and organisation. Everything about farming is loved by this type of farmer and they can't imagine doing anything else!

2. **The Flexible Strategist**

Activities out-side of the farm gate are motivating for the flexible strategist who is a lot more likely to run the farm as a business while balancing other areas of life such as family and 'town' activities. It's likely that this farmer will be off the farm and pursuing other ventures before they retire.

3. **The Environmentalist**

Nature and conservation are highly valued by the environmentalist. Often they will have little to no chemical use on their farm and they are always striving to maintain environmental awareness. Family and lifestyle is there to be enjoyed and the farm is a big contributor to reducing any external stresses.

Values have been described in four categories by Gasson, which are Instrumental – income focussed, Social – where family prestige and being part of the farming community is a focus, Expressive where personal growth and ownership is a priority along with self-respect and the chance to be creative and original, and also intrinsic where interdependence and enjoyment of work is important and the 'farming' life is rated very highly. It is the order of relevance that each of these four values will determine the decisions being made by farmers. Profit is not necessarily the number one driver! (Gasson, 1973)

"Farming is a vocation which may be valued in its self " (Joyce Willock, 1999). Decisions are not always driven by profit. Other factors to be considered such as the way of life, farming as a vocation to be valued in its self and increased environmental pressures which may come at an expense to profit when prioritised.

Research that has been focused on the individual level of analysis has shown that farmers have a variety of goals, although two predominant types have been identified: those with an economic basis and those that are focused on social and lifestyle concerns. (Fairweather, 1994). It has also been said that within these farming values (above) two main types of objectives can be identified: those

relating to economic factors and those relating to job satisfaction. (Joyce Willock, 1999) Similarly, Robinson (1983) found that the highest rated objective among farmers was to make a sufficient profit, while the second highest was "being good at what you do."

Farming Environment – Social Pressures

There are many environments that could be considered when you look at a farmer's performance. The natural environment is the obvious, where climate and land type are big contributors. The political environment and the ever changing technological environments must also be considered. However, the social environment was one that I had not considered before and it has now been realised that this may also have a significant influence on performance.

According to farmers themselves, in Burtons study, a 'good farmer' is seen to be one that has the best quality of livestock. An easy way to judge farmers 'ability' is to look over the fence at the physical presentation of his stock. (Burton, 2004) Farmers are often seen to be looking over the fence at what others are doing, and obviously the first thing they notice is the visual aspect of a farm or the quality of the livestock. Stock that is not visually appealing can be detrimental to the reputation of that farmer. Social pressure plays a big part in how farmers may uptake new practices or new technologies especially if 'loss of identity or social rewards' is a possibility. Many environmental factors that effect farm income are out of the farmers control such as fluctuations in market prices and the weather. However, the yield or the physical attractiveness of livestock is often a direct measure of the husbandry ability of the farmer which is therefore thought to be a much better indicator of a 'good' farmer compared to an economic measure that maybe out of the farmers' control, (Burton, 2004). The physical attractiveness is actually something that can be controlled by the farmer, whether that is through genetics or through management and feeding.

Methodology

1. Qualitative interviews with 10 commercial farmers. Over the phone and face to face.

Farmers were chosen to try and get a variation of high performing farmers and average performing farmers. I used my own industry knowledge and contacts to select the farmers and also recommendations from colleagues and other farmers.

The objectives of these interviews came under 4 main headings

- To get a feel for the demographics of the farm and also the overall performance of their farm. I wanted to understand how progressive they were and what practices that they were doing on farm to make them a high or low performer.

- To understand the genetic potential of their livestock. This included asking them questions about where they were buying their stud stock and understanding the type of genetic progress that they had made over a period of time. I wanted to understand how they were making decisions about the stud stock they were purchasing and what kind of information they were using to make their decisions. I also wanted to understand the relationship that they had with their breeder and how much they knew about their breeders' objectives. The biggest thing I was looking for here was, - were they using breeding values to make their selections?
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- To understand the type and quality of advise that they received on farm, especially in relation to genetics. I wanted to understand who they talked genetics with, and how often they talked about genetics. I was interested to know if they had heard of Beef and Lamb Genetics (BLG) and if they were following the research that BLG are doing such as the progeny tests.
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- To understand what information they sourced themselves and whether they were happy with their knowledge of genetics or if they wanted more information on how they could take production to the next level. I wanted to also get an understanding of how they learn – for example, if it was through their own reading, through other farmers and discussion groups or whether they attended field days or not.

2. Qualitative interviews with professionals that were close to the animal genetics industry.

This included stud breeders, an animal geneticist, a farm adviser, and a veterinary adviser. The objective of these interviews was to understand, from their own experience, if they thought there was a gap in commercial farmer knowledge of livestock genetics. I also wanted to understand why or why not they thought there was a gap, and whether or not this was an issue that needs a solution.

If more time was available, I would have liked to talk to more consultants and other industry professionals with an interest in genetics. It would have also been good to talk to stock agents as they have often been highlighted as advisers in this area.

3. Quantitative interviews via social media and through the Beef and Lamb e-diary.

I wanted to get as many farmers as possible to answer 20 short questions.
The survey was open to sheep and beef farmers and also to dairy farmers.
I distributed this survey through both my Facebook and Twitter social media accounts. The post was shared by many other people including the NZ farming group (93,000 followers), and the Farming mums group (8000 followers). I emailed the link to this survey to another few contacts such as Martin Coupe (National Beef and Lamb farmer Council) who passed it onto his regional managers.

After 1.5 weeks of the survey being online I then contacted Paul McCaully from Beef and Lamb NZ who got the survey into the BLNZ E-Diaries which is circulated to farmers and industry professionals.

The objectives of this questioner were the same as above but the questions had to be short and written in a way that was really easy to understand.

- The first 5 questions involved understanding the farmer demographics.
    - What was their age, farm type,
- Questions to understand how they rated their knowledge of animal genetics and what was important to them in terms of their stock performance. I wanted to know what information they wanted from their breeder and to know if they were happy with the current performance of their flock/herd. I also had a futuristic question in there to assess how progressive they might be when thinking about genetics.
- Lastly I wanted to gain information about how they learn.

I encouraged answers from Dairy farmers by having the option to tick dairy farming. I thought it would be interesting to see if there were comparisons between what dairy farmers were wanting and what sheep & beef farmers were wanting.

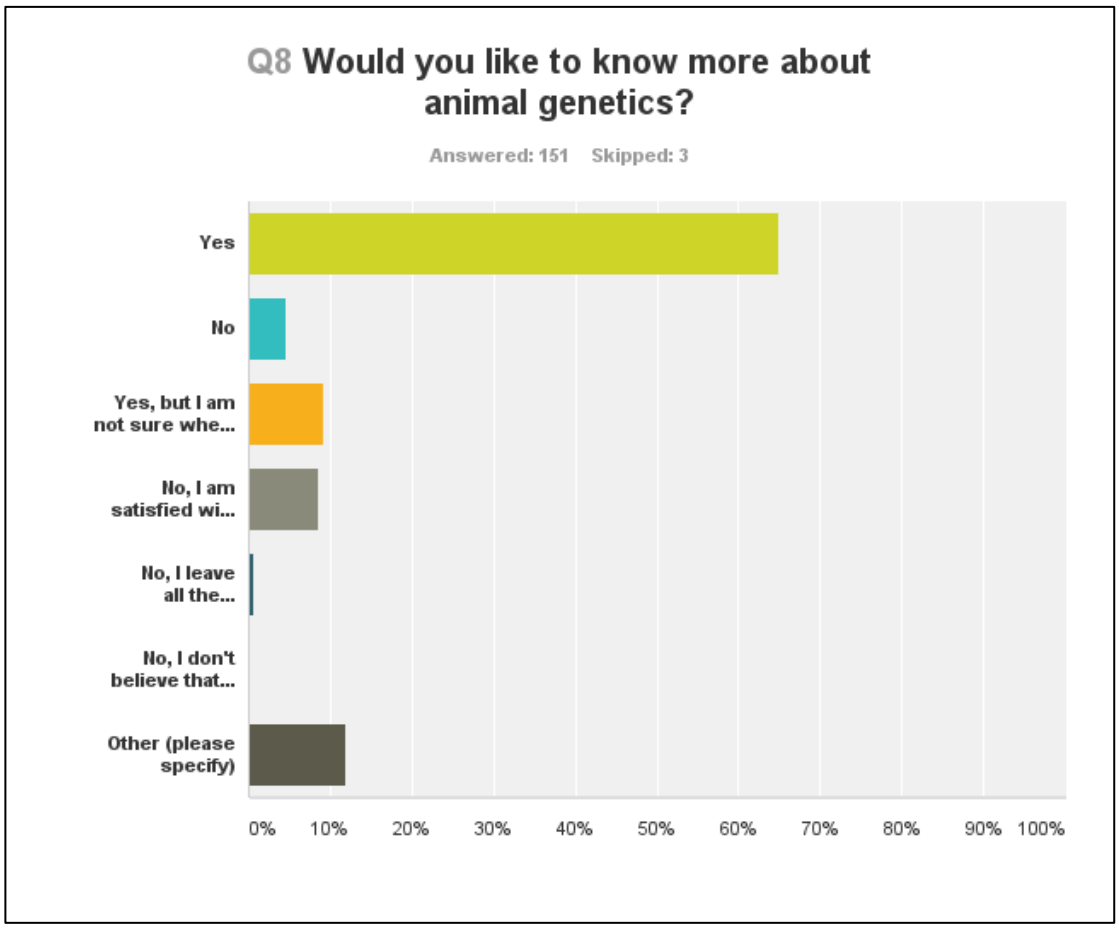
Results

After analysing results from this project, the first question to ask was:

Is there a gap in farmer understanding of genetics?

When asked if they would like to know more about animal genetics, approximately 75% of people who answered the online survey said yes. This was an obvious indicator that they wanted to improve their understanding.

Figure 1. Question from the online survey to ask if farmers would like to know more about animal genetics

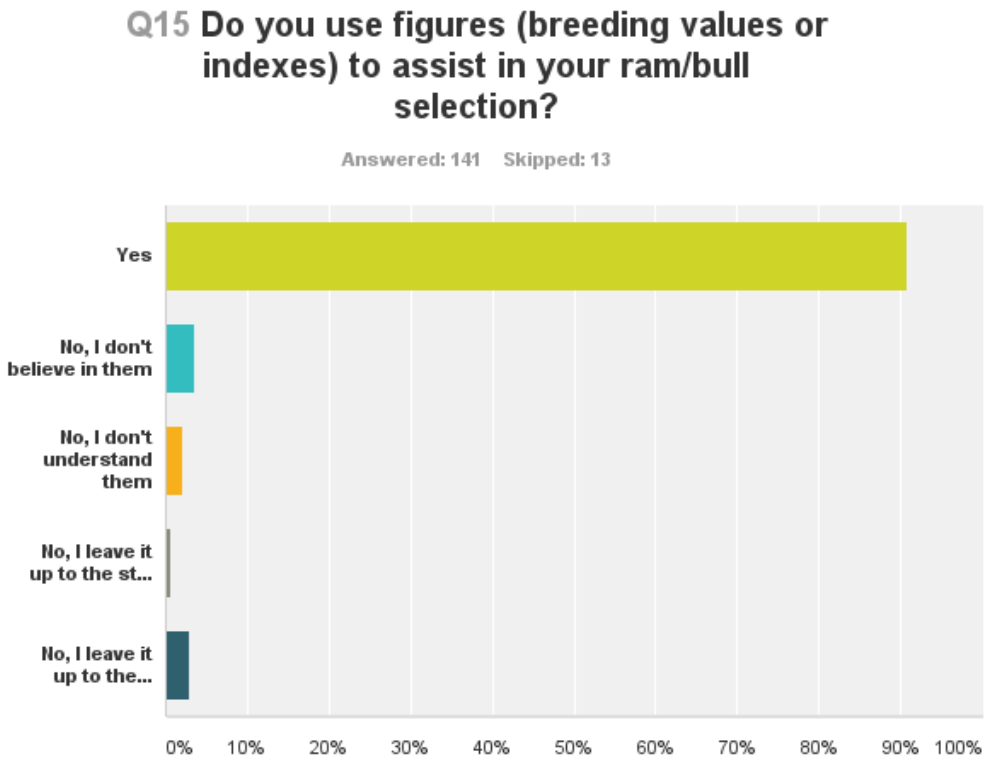


The question was asked more directly to advisers and ram breeders.
Do you think there is a gap in farmer understanding of genetics? 100% of the people interviewed said yes.

To understand whether farmers believe in breeding values and hence believe in evaluating the genetic component of livestock production, I asked if they were used to make their stud stock selection. 90% of the online responses said yes.

In hindsight, a question to ask would have been - how do you use breeding values to make your selections?

Figure 2. Question from th eonline survey to ask if figures are used in ram/bull selection.



From the results, 90% of commercial farmers are using breeding values. This conflict with answers from breeders in the qualitative interviews who say that approximately 50% of people would buy on breeding values, and the other 50% buy on what they can see or through the stock agent or the breeder. BLG had asked asked a similar question to farmers and come to the conclusion that 90% of rams were bred using SIL, but only 30% of rams were bought using SIL figures, (B+LNZ Genetics, 2008). However, one of the breeders surveyed said that 100% of his clients were use breeding values, as he has insisted that it is essential and had taught them all they needed to know.

This conflicting response may be accounted for by addressing a limitation in the online survey. As the majority of responses came through social media only a certain audience would have been engaged.
Those that were computer savvy, online and hence of the exact demographic identified by Corner-Thomas, that is more likely to take up and use technology, (RA Corner-Thomas, 2015).

It was obvious from the qualitative interviews that there is a range of how big this gap is.

- Some of the interviewed farmers were very knowledgeable but others just left the detail up to someone else, usually their breeder.

Some of the more obvious traits of the 'knowledgeable farmers' were their inquisitiveness and open-mindedness.

Some of the farmers said that they knew they should be putting more effort into their ram or bull selections but they have other things to think about.

Why is there a gap in commercial farmer knowledge of genetics?

Farm consultants and breeders were asked directly why they thought there was a gap in farmer knowledge of genetics.

"It could be made a lot easier"

"Breeders struggle to communicate the messages themselves. At the end of the day they are farmers, not marketers"

"Pub talk is filled of unqualified and mythical information"

"We only talk genetics once a year- whereas we would talk about animal nutrition or pastures every day"

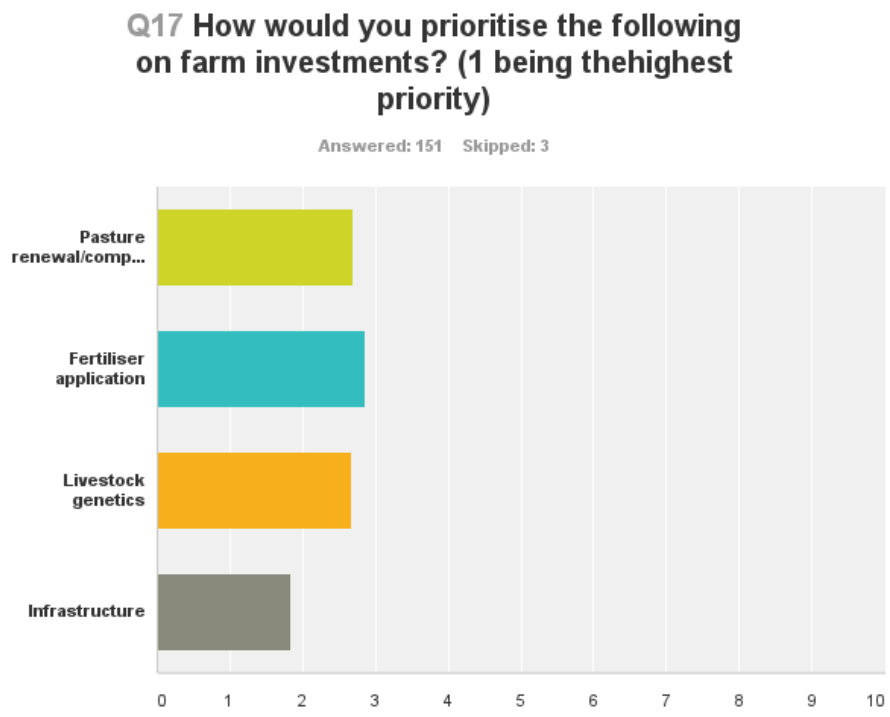
"Genetics is a long term gain"

"They can't see past what the animal looks like from the outside"

"Talking about genetics means they have to talk about performance"

Initially it was thought that genetics might not be a priority so the question was asked about the priority of on farm investments.
The below figure shows that genetics is rated just as highly as pasture renewal, fertiliser and infrastructure. Again, this is only an indication within a specific demographic.

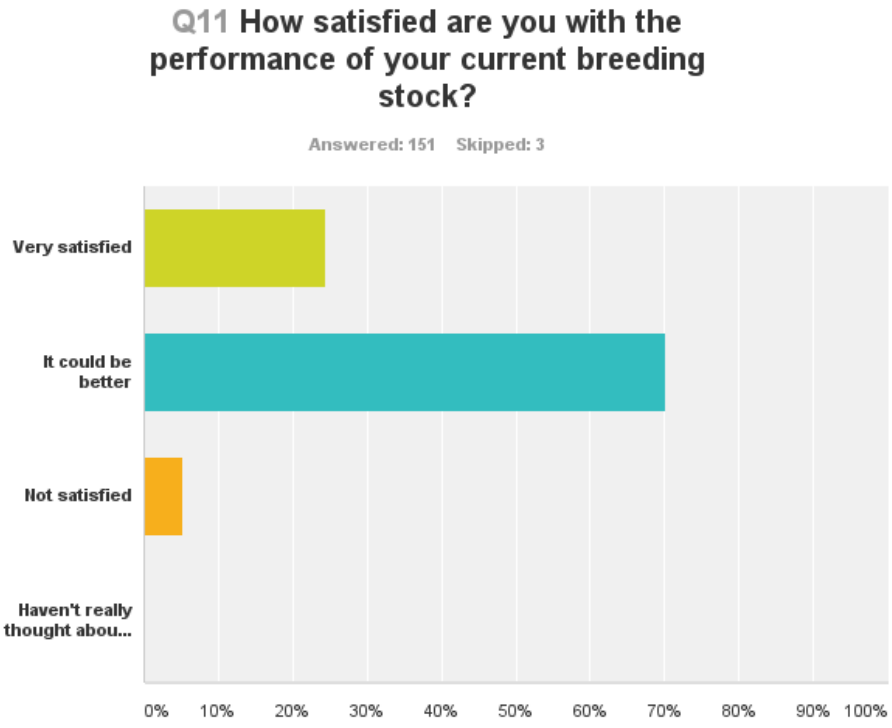
Figure 3. Question in the online survey to ask how farm investments are prioritised.



Is this gap an issue?

Figure 4 show that 70% of farmers responding to the online survey think that their stock performance could be better.

Figure 4. Question asked in the online survey to find out about the satisfaction of farmers with their current breeding stock.



I wonder if "always wanting to be better" is a common attitude of farmers?
As in the qualitative interviews two farmers expanded on this and said "I always want to do better" or, "there is always room for improvements".

Industry professionals were asked directly if they thought the gap in knowledge was an issue. Yes was almost always the answer.

"There is a lot of lost opportunity if genetics has not been considered in the farm system"

"Farmers need to get their animal nutrition/feeding right first, but genetics is definitely the next step"

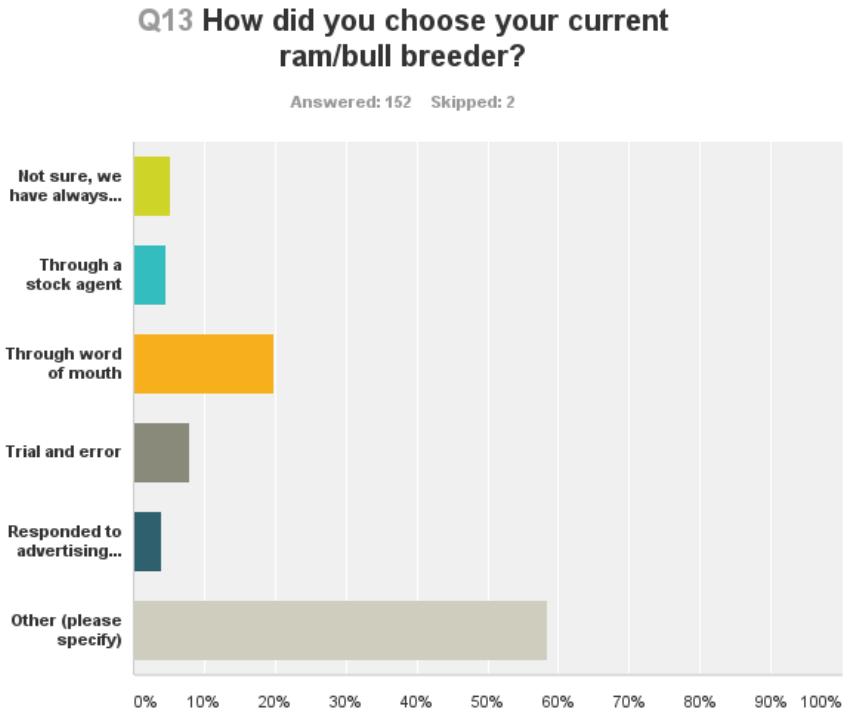
"We are always looking at ways that we can improve"

What is the solution?

Better advice?

Farmers are not likely to seek advice about selecting rams/bulls from consultants, vets, or stock agents. This was seen in the online survey and it concurs with other research such as in the RMSS and a survey done by Pfizer Animal Health, where a similar question was asked of farmers where they were seeking advice about their selection decisions. They are using their own means of information gathering.

Figure 1. Question from the online survey to understand who farmers were going to for advice.



A strong theme come through from the "other" category where judgements were often based on 'word of mouth' and getting opinions of other farmers. This is a trait of farmers that the industry is aware of – farmers learning from other farmers. Basing information on past experiences was another theme.

"Did my own home work. Past experience. Friends past experience. Data"
"Stud visits. Look at lots of sheep. Talk to other farmers"
"From seeing the animals, researching their family history and using my judgment"
"Advertising. References of other farmers using them. One on one interview and interrogation"
"Own research on what is out there. What other farmers have"
"Knew what we wanted, then talked to a lot of people"

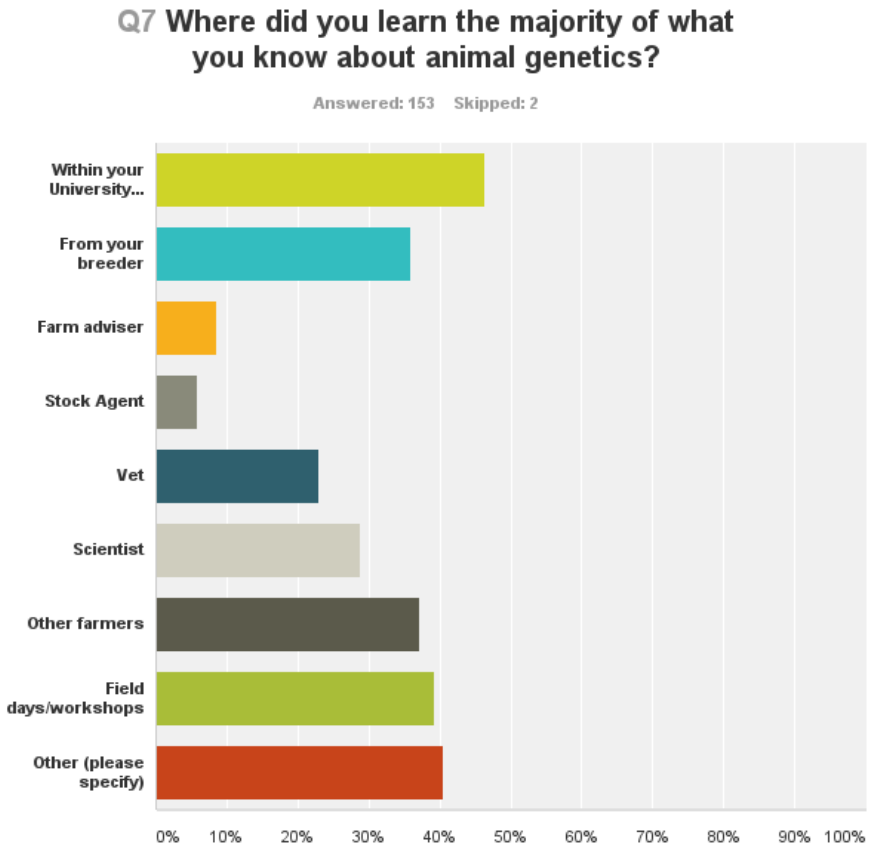
"Through experience and knowledge gained over the years from working on top performance properties"
"By looking for breeder willing to help with my genetic plan and who walks the talk"

Some of the comments did refer to using actual performance information like breeding values but only about 20%.

"Reputation, SIL data. Objective measurement and eye appraisal"
"Researching breeding values and looking at what breeders fit what we are doing"

However, from the survey it is obvious that farmers are likely to use others when gathering their information to form their own opinion. For example, when asked what sources were used to educate them on genetics, there was a wide variety used.
This was also a common theme from the qualitative interviews.
The most common answer in the "other" field was experience. When compared by age there was a positive correlation to age and the use of 'experience' to describe their current knowledge.

Figure 2. Question from the online survery to understand how farmers were sourcing their information.



More field days?

According to some industry professionals, it is the progressive farmers that often attend the field days. In this case, they are potentially "preaching to the converted"

Yes, if they are going to talk about what they say they are going to talk about and if they are respectful of my time"

There are so many different ways in which farmers can access material and it really depends on the individual farmer.

" I like to read because I can do it in my own time"
"If I have time to be off the farm I would rather spend it doing something with my family"

A number of vets were asked about advice that they may give farmers on 'genetics'. Often the answer was, "we never get asked" or "it never really comes up" or "there are a lot of other ways in which performance can be enhanced, such as animal health! So in that case, genetics isn't often the first point of discussion"

What is it we need to be educating on?

Figure 3 What aspects of genetics, or animal breeding would you like to know more about?

Farmers are looking for detail on the specific traits.

Genomics indicates that they are looking for information on new technologies that are becoming more available and more cost effective.

Genetics was followed by gains, trends, and defects/diseases

Genetic modification only came up once.

Epigenetics was mentioned once. Heritability comes up quite a bit which was interesting.

Figure 4 What information would you like to help select your breeder?

Farmers want to know about their breeder and the breeders' performance.

They want to benchmark breeders but also match them with their own objectives.

They want data on the breeders and data on the performance.

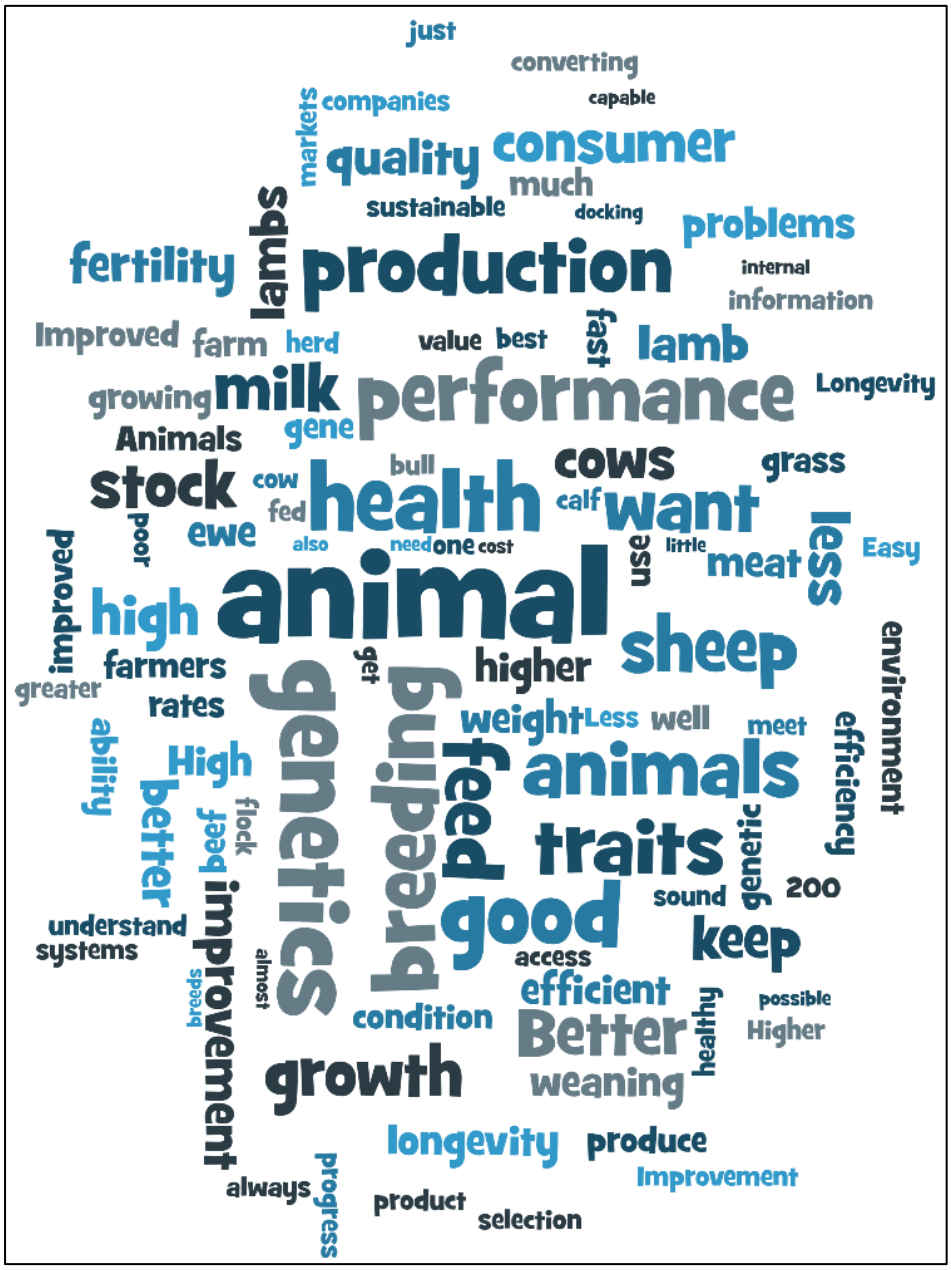
"Full transparent breeding values "the truth"

"Breeding values or indexes and the breeders integrity and their operation"

"Benchmarking information performance when measured against others"

"Transparent information on genetics and performance that is relative to all studs"

Figure 5 Looking forward 10 years, what do you want from animal genetics?



Answers here could be categorised into objectives of

- Environmental awareness/ Animal health
- Market/consumer driven – i.e. Value add
- Production or performance driven – getting more from less

The majority say that they use breeding values or figures when selecting their stud stock.

The open-ended questions in the online survey allowed me to get an understanding of the type of language that was being used when answering the

genetics questions. Really simple words were being used such as traits, breeding, genetics, information, and data.

This conflicts with the words that are used by industry professionals such as genetic evaluations, breeding indexes, genetic trend graphs.

- Genomics was often referred to.

- Trust/ openness was often referred to. Integrity

What is the solution?

This was the direct question that was asked to the industry professionals and breeders. Simplicity"
Genetics is put in the hard basket because of its complexity.
Leave the complex bit up to the scientists and provide the information to farmers that they can actually use."
"Data turned into information"
"Better tools to assist in decision-making about what rams or bulls to buy"

"Showing more examples of people getting it right"
"Getting more people talking about genetics every day"

"Myth buster. What's important, and what do you not need to worry about"

"Farm advisers just about need a degree in psychology". This was a comment made twice when interviewing two different advisers, on separate occasions.

Discussion

The first objective of this project was to confirm my belief that there is a gap in the understanding by commercial farmers when it comes to animal genetics. Secondly I wanted to understand why there was this gap and lastly I wanted to draw some conclusions for possible solutions to close this gap.

I was able to extract from the survey and the interviews that, yes, there was a gap in understanding. There were some hints in the written answers and from talking with the industry professionals about why there is a gap, and what solutions might be for closing it. The literature helped me to go to the next level in understanding, **why** there was a gap in understanding of animal genetics, by making associations with farmer behaviour and therefore farmer performance. This discussion will describe each of the three objectives, by drawing on themes while comparing and contrasting the literature, the results from my survey, interviews with farmers and industry professionals and also my own thoughts that have been shaped by the former.

Is there a gap in the commercial farmers understanding of animal genetics?

Every adviser said yes. Every genetics professional said yes. The majority of the breeders said yes. This was just the conformation that I needed to keep going.

It is however worth noting that the knowledge gap definitely varies from farmer to farmer and this is explained further below.

Why is there a gap in the commercial farmers understanding of genetics?

Firstly, there were some very simple explanations that come out of my research to describe why there is a gap in the understanding of genetics. For example, you can't see it, it's a complex subject, it is a long-term game and there is limited information being shared with the commercial farmer, on animal genetics.

You can't "see" genetics. You invest in fertiliser and with a few weeks you notice an obvious difference. You give an antibiotic to your stock and you can see that they are noticeably better within a few days or a few weeks. Production in the same year can significantly be increased, just by feeding stock better. There are many other ways to increase production that are much more obvious to the eye compared with investing in genetics. Farmers tend will default to talking about what they can see. In terms of their stock, what they "see" is structure, size, weight, colour, and conformation – so hence this becomes the common language.

Genetics is a difficult subject to both understand and to talk about. "Even stud breeders find it hard to *understand*, let alone explain it to their clients". "Talking about genetics means talking about production and farmers don't like to talk

about production". To single out genetics when analysing an animal's performance, you have to start talking about breeding values, indexes and genetic trends. This can get complicated and is often put in the too-hard-basket. "Genetics is often only talked about once a year at ram or bull sales, as opposed to pasture that we talk about every day".

Genetics is a long-term game. You buy a ram in one year and it's not until about three or four years later that he has some daughters who are lambing. By that time, more rams have been purchased so it gets hard to distinguish the performance of the ewes, or their lambs, that were born to that original ram. Let's say that a commercial farm has ewes that are 8 years old. That means the ewe flock will still be made up of genetics that were purchased 9-10 years ago. Genetics is a long-term game, and it's hard to keep track of.

Who is giving commercial farmers advice on animal genetics? Currently in New Zealand, we do have a strong presence in the animal genetics space. We have our committed and passionate breeders, outstanding and leading scientists, consultants who sit in between the scientists and breeders, stock agents who sit in between breeders and commercial farmers, commercial providers of DNA technologies, universities and of course, beef lamb genetics who have a focus on extension to breeders. Scientists and geneticists are often in touch with breeders and maybe commercial farmers, when doing research. Scientists speak a different language compared with farmers and often the research is not passed on in a practical sense. Stud breeders have a role to supply the industry with elite genetics. The breeders may generally understand the genetic concepts which have been passed to them from the scientists, but they may have trouble explaining them. Marketing is often not the priority for breeders. They may have a specific marketing team, who may not be trusted anyway because of the high rate of turn over, and are just seen as trying to 'sell' farmers something. Vets see very clearly that there is a lot to be gained from improving feeding on farm and having the ewes in better condition and this is the first step that they focus on for improving performance.

Stock agents are in between the commercial farmers and the breeders. They might not be seen as advisers, but they carry a lot of information about other farmers and about breeders. They have a big reach out to commercial farmers and are often seen to update other farmers on local information. No specific training in animal genetics is required and their genetics knowledge is purely based on what they can 'see' or what they have learnt from breeders. They are seen to be "bias" by many of the farmers that were surveyed. Regardless of whether they are used for 'advice" they are still seeing a lot of farmers and discussing the performance of stock. However, it may not be performance in terms of genetic potential.

There is not currently an obvious pathway of knowledge transfer to commercial farmers. But information is key??

Secondly, in the literature review I compare farmers with the same 'phenotype' concept that, in the genetics world, we use to compare sheep. The phenotype is the physical appearance and performance of a farmer. The phenotype is a function of a farmers' genotype – the values and objectives that are passed through generations, and also the environment – which include the social pressures of farming. I will use this concept to describe my findings and to discuss how, I believe, it relates to a farmers understanding of animal genetics.

$$P = G + E$$

Phenotype = the Genotype + the Environment

Phenotype = Physical performance and appearance.

It is seen very clearly across the industry that "no two farmers are the same", (Beef and Lamb Genetics, 2016)

The average age of a New Zealand farmer is 56. The Red Meat Profit Partnership (RMPP) clearly defined the varying performance in farmers across the sector and categorised them into top performing, mid performing and low performing. The RMPP looked at the whole farming system to define these categories of which I am not going to describe in detail, B+LNZ, MIA. (2011).

When it comes animal genetics in particular, there is also a defined range in understanding both by stud breeders and commercial farmers. These could also be categorised into a high understanding, mid understanding and low understanding.

-High Understanding
These are farmers that are very passionate about the genetics of their stock. They have very carefully selected their breeder and they only buy top tier rams. They have a specific objective for the type of sheep that they want to produce and this is very much based around high productivity. They understand that genetics is definitely a player in their success, behind the farm gate. The tools for genetic selection are widely used and understood. "Breeding values are a given- they work." They are striving to always improve so they are always gathering as much information as they can. They will likely want to talk straight to the scientist so they are getting their information "straight from the horses mouth". They are also often involved in the research such as having progeny tests run on their property. However, if they do not totally understand the ins and outs, they surround themselves with those that do and are willing to take advice from specialists, or other farmers. "You don't have to understand exactly how the engine of a car works, before you drive it – someone else does that, and you just need to trust that it is going to work". It is often the next generation of farmers that have this mind set. They are not afraid to question what they don't know as they accept that they have their own specialty.

-Mid Understanding

There are farmers that are passionate about animal genetics and those that don't really think about it or believe it makes a difference. There are also farmers that understand it's important but have just not yet had it proven to them. Once they have had someone describe it to them, their eyes light up at the new information and the new opportunities that it can bring to their farm system. Once they gain some knowledge of the tools or the information available then they are fairly quick to change their ram buying process, or to further analyse their own objectives and compare it with their breeders' objective.

- Low Understanding

There are farmers that are passionate about their animal genetics, and there are also farmers at the other extreme that haven't even really thought about it. They do not use the tools available (breeding values), maybe because they don't understand them, maybe because they don't believe in them or maybe because they don't know they exist. They buy from the same ram breeder that they have always bought from because it is often more about the relationship with the breeder. After they buy their stud stock they don't really give the performance another thought and don't have a way to monitor if those genetics are actually working for them. They are mostly of the belief that it is "90% feeding and 10% genetics". They are very focussed on the appearance of the stock, which makes up the main method for ram selection and will almost always be chosen over their breeding value.

Genotype = Values, goals and objectives that have been passed down through the generations.

It's a given, that values and objectives are a big influencer of performance, in any industry or wherever people are involved. There has been a lot of work around specific values and objectives of farmers, both abroad and also specific to New Zealand. As above, the RMPP talks about top verses low performing farmers and relate this back to specific "drivers" of the different groups - such as their appreciation of lifestyle verses the profits that they can make. BLG has it in their tag line that "Not all farmers are the same, nor are their management styles". Fairweather categorises New Zealand farmers into three different management styles. I have reflected on these styles, and have applied a genetics flavour, as they really resonated with the answers I got in my survey. Often we hear that values are passed through the generations so I think it is appropriate to put these in the "genotype sector". I think the various phrases of "farming is in the genes" confirm the appropriateness of this. It is important to think about values and objectives when it comes to breeding good genetics, selling genetics, buying genetics and just talking about genetics in general.

1. **The Dedicated Producer**

It is obvious that some farmers are just all about farming. They consistently work hard to keep improving and are just motived by being out there and doing the work. When it comes to animal genetics I use this category to describe the farmer that has

a strong focus on the performance and therefore the production of their stock and how this contributes to the profitability of their farming system. The dedicated producers are likely to be the farmers that are using all of the available tools (such as breeding values) for ram selection or if they are not, it's likely because they haven't yet been told about the tools or how to use them. A trait of these producers is planning and strategy so they are likely to have figured out ways to monitor the performance of the stud sock that they buy, and give feedback to the breeders on what they could do better, or use different breeders for the different performance that they can bring.

Comments from this type when asked what they want from their animal genetics are as follows,

"To improve the performance of my flock"
"Consistent progress"
"More return $ at the farm gate"

2. **The Flexible Strategist**

Some farmers love to farm but they also love to be off farm. Whether that be just spending time with their family or looking at other ways to make a return off the farm. When it comes to animal genetics, these farmers are looking for efficiency. If they are running a simple but effective system it means that they can spend more time off the farm. They are looking for sheep that are 'easy care' and efficient at converting grass to product. This type of farmer is likely to be the one that is, or is interested in, producing their own branded product, as this is another means for making money. For this, they are again thinking beyond the farm, and to the consumer. There is a known correlation between genetics and eating quality.

Comments in my survey that described this type of farmer, when asked what they want from their animal genetics in the future are as follows,

"Easy Care sheep, no dagging, no drenching, no docking"
"That they produce animals that our markets want, not only what sheep farmers want"
"Value added branded product"

3. **The Environmentalist**

The first thing that some farmers think about is the environment. They value the environment highly and will often put production behind the environmental footprint in terms of priories. When it comes to genetics these are likely the farmers that want to reduce the amount of chemicals used on farm so breeding for less worms and therefore less drench required, would be a focus. There are also farmer in this group that have to consider the environment more because they are in areas that prone to facial eczema or just more worms in general.
In the survey they are mentioning factors such as,

"The NZ clean green image"

"A high performing, healthy, low input (chemicals) stock"
"Environmental impact"

$$P = G + E$$

Phenotype = the Genotype + the Environment

A farmer's performance (phenotype) is a function of their values and objectives (genotype), and the environment. By understanding what the traits of farmers were and understanding that this was something that was in "the DNA" it was easy to see why they were performing in the way they did. Why they were focussing on other traits such as worm tolerance or marbling, as opposed to straight production traits like growth. Either consciously or subconsciously these traits of farmers, will be a contributor to the performance made on farm. Profit, is not always the number one driver. Fairweather finishes his paper by stating that,

"Technology transfer might be much more successful if extension practitioners understand how farmers with different management styles might react quite differently to information or advice about new techniques or approaches to marketing" (Fairweather, 1994)

To the ***dedicated producer*** we should be talking about the overall system and a balanced sheep or beef that will grow efficiently and maximise their profitability. They want to see that the genetics are improving, year on year, and that the breeder is doing everything they can to maximise the returns for farmers buying their stud stock. To the ***flexible strategist*** we need to be talking value added. What traits of the stud stock will allow them to get more returns off farm in ways like marketing their own meat? Ease of management is a priority so that they can have more time off the farm. Talk about the reduced requirements for drenching because of the flocks enhanced tolerance to worms or the fact that they are genetically prone to less dags. To the ***environmentalist*** we should be talking about the animal health and again, about the low drench requirements of more worm tolerant sheep.

It is important to understand a farmer's genotype, so we can make associations to his/her performance.

The Social Environment

A farmer's performance is a function of his/her genotype (values and objectives) and the environment that he/she farms in.
There are many ways in which the environment can affect the performance of a farmer and his/her stock. The physical, political, technological and social environments all must be considered. The obvious one is the physical environment, such as the weather or where in the country they are farming and the type of country that they are farming on. The genetics by environment (G by E) concept is often talked about which is where some genetics may perform better or worse in different environments. As mentioned earlier some

environments may be more prone to worms or the spores that cause facial eczema, which will affect stock health and therefore performance. There is the political environment and discussions around the likes of the ability, or not, to influence production through genetically modified organisms. Technology is also an environmental factor that is playing more and more of a part in farming and having an influence on performance whether it be through genomics (DNA technology) increasing the rate at which genetic gains can be made, or electronic identification (EID) technology which makes the management of stock a lot more efficient. An obvious factor for the social environment is succession. Whether or not there is a son or daughter coming through that wants to eventually take over. It is often the younger generation that understands the science of genetics and how the tools like breeding values are used to make better selections to increase productivity.

It was only through reading the literature that it was realised that there is another element of the social environment that plays a significant role in the genetics world – social pressure.

It is described in the literature by Burton, that a good farmer is one that has a "good yielding crop" or has "a good looking and even line of stock", (Burton, 2004). Farmers will judge other farmers based on the appearance of their stock as this is the first means of appraisal before asking about performance. Whether it is judging them from over the fence or in the sale yards, it's the appearance of that stock that will form the basis of judgement. This provides us with a lot of answers as to why talking about the appearance of livestock always seems to be the default. What they look like. Whether they have a pink nose, an open face, a good head, black spots, correct feet, or an alert stance. A lot of the time, appearance or conformation is prioritised before the potential performance and therefore profits of that animal. Genetic potential can't be 'seen', but physical potential can. If a farmer can breed livestock that are appealing to the eye then other farmers see them as being better farmers.

Social pressure must also be considered. The farm consultant that was interviewed stated that "farmers are very influenced by other farmers". Bulls may be only bought from the most expensive stud, because they are the 'trendy' stud to go to.

What are the solutions to close the gap in the understanding of commercial farmers, when it comes to animal genetics?

The above question was asked to farm advisers, to breeders and to other industry professionals throughout the process of conducting this research. The biggest themes to emerge here was the need for information about: basic genetics, breeders, information be provided in an easier to understand form, information from other farmers and finally information with integrity. There is not currently an identified pathway for information to be transferred to commercial farmers. The two other themes I will also describe are empowerment, critical thinking and self-awareness.

- **Information**

Information about breeders. It appears that commercial farmers want information on the breeder themselves. Things like 'breeder integrity', 'family history' and breeder performance. The best way to get this information is from other farmers and the experiences that they have had with that breeder. Often the relationship between a farmer and a breeder is valued very highly and this is purely the reason for a farmer buying rams from that breeder instead of objective measurements that lead to production gains. When farmers are asked if they would like benchmarking information about breeders, they often smile and say, "Yes, benchmarking is exactly what we need". A message that is often given by genetics professionals is - "the most important decision you make, is what breeder to buy your rams from". Farmers' need objective but transparent information about their breeders.

Information, in the same language. Breeding values are being talked about by the younger, educated demographic and are realised as a vital part in selecting stud stock. "Breeding value" was the most common phrase used to describe performance measurement as opposed to indexes or genetic trends, which are talked about by scientists and other professionals close to genetics. All of the performance data being asked for by commercial farmers, is available to breeders though the evaluation platforms such as SIL (Sheep) and Breedplan (beef). However, potentially this data is not being turned into simple and practical information for both the breeder delivering the message and the farmer.

Information from other farmers.
It's the same in all of the other aspects of farming. .. Farmers learn from other farmers. More farmers would get on board if they were seeing other farmers having success with their genetics in objective terms.

One of my farmer interviews was with someone who had been in a recent Country Wide article and was talking about the exceptional performance that they were getting from their stock. The reasons for the exceptional performance as explained in the article were "because of a significant change they had made to their feeding regime". After having a conversation with this farmer about his genetics, I soon realised that this was something that he was also doing very well! I asked him why he didn't mention genetics in the article and he said "oh, I have always known that I needed to have the top genetics, I just realise now that I wasn't feeding them right. Now I know that by getting the feeding right, it allows them to express their true potential". So, genetics was actually the first step and to him it was common practise and not worth mentioning. However, this would have added another level to the article and indicated the performance that can be made when all of the farming systems are working together - including genetics!

Information with integrity.
Words relating to integrity come up a lot in the results. Farmers want honest information about the breeders, about the animals and about the performance of

both. Its all to easy to exaggerate the lambing percentage to sound like "better farmers" but this does nothing to the integrity information that is being received. There are so many myths in the industry and many of these are about genetics. Farmers are influenced by other farmers and myths are often blown out of proportion if they are told to enough people.

- **Empowerment**

When it comes to decisions about what breeders to choose or what rams or bulls to buy, farmers do not want to leave this in the hands of someone else. On analysis of the results it seems that farmers will collect as much information as possible from as many different sources available, including, scientists, discussion groups, farmer magazines. They want to use this information to make their own informed decision about the genetics that they buy.

Farmers are generally confident in their knowledge of genetics but at the end of the day they don't know what they don't know and they are always looking to improve. The next generation of farmers are more likely to ask questions, instead of relying on previous experience.

- Applying critical thinking

In the surveys there were numerous examples of critical thinking mentioned.

- Being open minded and always questioning why or why not breeders are recording certain traits or making progress in particular areas.
- Farmers and breeders need to be honest with themselves about the production that they are currently getting, acknowledge what they don't know and be critically aware of the sources that they are utilising for information.
- Seeking true evidence to base their own judgements. Being influenced by those that are 'walking the talk' and have true means of evaluating their performance.
- Thinking about problems as an opportunity. How can they utilise genetics to help them reduce gaps in their system, such as not having the weaning weights they think they should.

- **Being Self Aware**

Being self aware is the first step to inquisitiveness. If you pretend to know everything then you create an image that leaves you not wanting to ask questions for fear of sounding stupid or of someone questioning our abilities. . Taking responsibility for what you don't know.

Asking questions also shows that it ok not to know everything and shows a constant ability to keep learning. Turning mistakes into learning opportunities. (Musselwhite, 2007)

Ben Allomes, in his Nuffield made the correlation between the higher performing farmers being more self-aware. This was also in relation to them being able to clearly articulate what their weaknesses were, but also their strengths. (Allomes, 2016). Also when you can understand your strengths and weaknesses you are in a better position to build a team around you, which may or may not be the specialists in that field.

Conclusions

There is a gap in knowledge of commercial farmers when it comes to genetics. This is perceived by advisers, industry professionals and genetics specialists. Reading between the lines of the farmer survey also suggested that there is a gap. However, just like RMPP identified, there are top, mid and low performing farmers. This also applies to the commercial farmers understanding of genetics. Some farmers are right up their in their knowledge, they are very specific about their breeder, they always buy the top tier of rams and they are often very close to the scientists involved in research. Some farmers are not interested in genetics and feel that they can make more gains from other aspects of their farming system such as feeding or pasture management. Some farmers don't know what they don't know. It's not until they have had a better explanation of the benefits of genetics that they see it as a solution to increased production. It is often the next generation that is looking to understand and utilise genetics more.

There are two ways to explain why there is a gap in the understanding of animal genetics. One is the more obvious reasons such as the fact that you can't "see" genetics, genetics is a hard concept to understand and explain, genetics is a long term game and there is no obvious pathway for transfer of information to commercial farmers. There is lots of proven information out there about how genetic gains can be made and there are tools available to separate animal performance in terms of their genotype and the environment. These tools should be used to overcome some of these obstacles.

The second explanation is by understanding the factors that drive the differing farmer performance (phenotype), the genotype – farmer values and objectives, and the environment – with an emphasis on the social environment. Farmers can be categorised by their management styles (often passed through the genes) and by doing this, it gives a good indication about why they are performing in the way that they are. The social environment is something not often thought about by genetics specialists. The pressure from other farmers to be "a good farmer" is very influential when it comes to farmer's performance and can obviously explain reasons for the physical appearance of animals being the default selection method. An animal is more likely to be judged by the way it looks, compared to its genetic potential, which will be a direct indication of how good of a farmer the owner is.

Solutions for reducing this gap are going to be mostly influenced by information. Farmers want information, in their own language. They want transparent information about genetics and the ability to benchmark breeders. They want information that is delivered with integrity. Farmers want to use this information to make their own decisions about what breeders they go to and what rams that they buy. Farmers need to be empowered by the industry and the genetics specialists to better enable them to make informed decisions about the rams or bulls they are buying.

There is a lot of money left on the table when it comes to animal genetics. It's a fast pace part of the industry and commercial farmers really do need to realise the benefits of selecting better rams and bulls to improve their genetic gain,

performance and ultimately their profits. Regardless of the style of farmer, genetics can be one of the solutions for meeting their objectives whether it is producing more meat, producing quality meat or simply producing efficient animals. A lot of this lies with the industry professionals who are educating farmers. They need to be better understanding their farmers and breeders and providing them with the transparent and quality information, with integrity.

In order to understand, and appreciate the value of their livestock genetics, commercial farmers need to be individually understood, and they need the information to be delivered to them.

Recommendations

- Collaboration across the genetics "players" to provide breeders **and** commercial farmers with quality information that is transparent and has integrity. Farmers need to be empowered with the information so that they have the ability to apply critical thinking and form an educated judgement about the genetics they currently have and the genetics they are aspiring to have. Everyone needs to be talking the same language. The focus should be moved from proving breeding values work, to instead, focusing in extension and describing how genetic improvement can be made in a simple, practical way – to commercial farmers.

- Again, collaboration. The rest of the industry also needs to think about genetics as a solution. We need to describe to accountants and bankers, what type of profits can be made. We need to be educating at an earlier age – *with up to date information*. Beef and Lamb need to be including genetics in their economic surveys – asking commercial farmers where they buy their stud stock from and compiling this information.

- Advisers need to be understanding farmers better. What are the genotype and the environmental factors that are playing a role in the way that a farmer performs? Solutions for farmers need to be developed in a way that is individual to the farmers needs. Advisers also need to be critical about their own information when it comes to genetics. Are they providing farmers with the most accurate, and up to date information?

- Farmers need to be talking about genetics more! Telling their story about how genetics has made a difference in their production! Helping the next generation to understand that genetics needs to be valued as part of the agricultural system.

- The genetics players, the advisers and the farmers need to work together to get away from judging based on eye appraisal and instead, make performance trendy! Regardless of whether farming is about the profit or about the lifestyle, genetics can make a difference!

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