2021

Scotch Beef PGI Traceability and Project

Summary Document

QMS

Introduction

Beef farming in Scotland is currently not fulfilling its potential. For example, in 2019 on average 82.4 calves were reared per 100 cows, considerably less than the rest of the UK and Ireland.

However, with improved performance the potential for additional profitability is significant. The need to change has never been more urgent as the industry faces a range of challenges which will impact ongoing sustainability. From changing farm support systems, environmental targets, increased market competition, changing consumer demand, and the requirement to improve product quality and consistency livestock performance has never seen such an upheaval.

That is why the Scotch Beef PGI Traceability and Performance project is so important. The project team identified that one of the most effective ways to combat the challenges in the beef sector is through the utilisation of DNA profiling of maternal DNA and then using that information and analysing it to give farmers the tools to make management decisions on farm to improve their financial and environmental sustainability. As well as this, harnessing DNA can guarantee full effective traceability from finished product back to the farm, and animal of origin.

Our proof-of-concept study aimed to test a system which could be used to address these challenges, while also highlighting the benefits of introducing DNA traceability to the Scotch Beef supply chain. The proof-of-concept study made recommendations for an industry wide performance enhancement programme, aimed at strengthening the foundations that the Scottish beef industry is built on.

A long term, advanced genetics and traceability programme could potentially deliver the following benefits for Scotch beef:

1. Scotland having world leading traceability and integrity levels for beef, through a database of DNA from dams in Scotland.

2. Scotland having a world leading beef production system, driven by advanced technology, to deliver animals with high genetic potential.

3. Scotch beef having better and more consistent eating quality, delivered through a combination of genetic improvement and industry targets.

4. Scottish beef production having a much lower incidence of disease.

5. Scottish beef production having the lowest possible environmental footprint by selecting for the higher performing, more efficient animals.

6. Scottish farmers having access to recommended, across breed, sire lists to choose sires which are proven to be the highest performing over a range of traits.

7. Eventually, Scotch beef being recognised as the ‘Ultimate Beef Product’, with high global consumer demand.

Ultimately, the Scotch Beef PGI Traceability and Performance Project was established to test two key objectives; the use of genomic analysis of maternal DNA to guarantee traceability, and utilising DNA and analysis to predict the performance of offspring.

Objective of Project

This project was operated as a proof-of-concept study to test the principles which could be applied on a larger scale. The main questions posed by this project were:

1. Can maternal DNA samples be collected accurately enough at farm level to drive a traceability programme?

2. Can maternal DNA samples be collected accurately enough at farm level to drive a DNA led herd improvement programme?

3. Can enough accurate farm management (phenotype) data be collected at farm level to drive an advanced genetic improvement programme?

The pilot programme was able to answer each of the above questions, concisely and definitively.

Method

A number of farmers, who supplied the same finishers, and ultimately, the same processor, were identified, and the details of 541 cows collected. DNA samples were then taken from all cows identified, and the samples were sent to our testing partner Identigen Ltd.

Progeny from these selected cows was then identified, and samples taken from a subset of them when they passed through the abattoir.

The abattoir collected samples of the finished progeny and a traceability test was done using the maternal DNA for reference. Once traceability sampling was completed, farm management data (phenotype data) was collected from the farmers involved.

Once finishing data was recorded, phenotype data was collated, and all data was sent to Moredun Research Institute for analysis with the maternal DNA.

Once analysed, the results of traceability and phenotype analysis were presented to the project team for conclusion.

DNA sample accuracy

The pilot programme showed that farmers could collect DNA samples which were of high enough quality to enable both accurate traceability and the use of DNA to drive a herd development programme.

Accuracy of data from farm level

The first of these was the collection of consistent data from farm records (phenotype data). While the farmers often had comprehensive data on farm management, the differences in format and recording styles made the results difficult to compare and contrast.

It should be noted that these difficulties were present where farmers had comprehensive records, and if the project were scaled up, there would be difficulty in collating and comparing such a variety of records.

The findings from the study clearly showed that the initial data used in a larger scale programme cannot be drawn from farm. The data used to drive a DNA programme must come from sources which are accurate, meaning that the initial data used for any larger scale project should be sourced from objective, external sources (such as Scot EID and BCMS).

Use of maternal DNA

The pilot programme demonstrated that maternal DNA can provide very accurate traceability when used in conjunction with BCMS and will be able to provide full assurance to Scotch Beef consumers.

The work in the project also showed that maternal DNA can be used to guide breeding decisions across the Scottish Herd.

Conclusions

The pilot programme concluded that:

- Maternal DNA samples can be lifted accurately enough at farm level to drive a traceability programme.

- Maternal DNA samples can be lifted at farm level to drive a DNA led herd improvement programme.

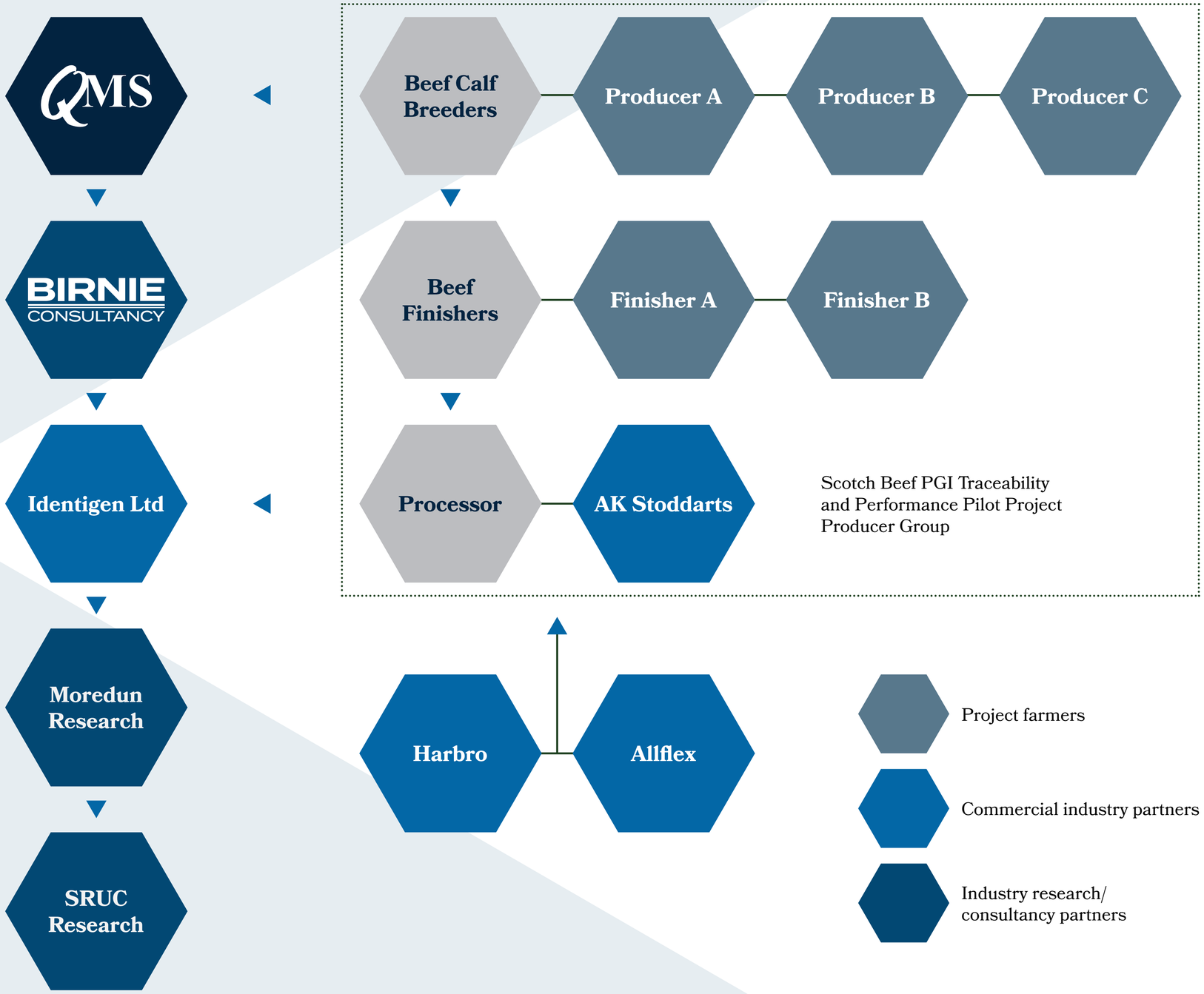
- Phenotype data can be lifted at farm level in order to drive an advanced genetic improvement programme however the accuracy and consistency of the data needs to improve to capitalise on all of its potential benefits.

- Provided that a large-scale project is carefully designed, maternal DNA can underpin the development of the national herd and Scotch Beef brand.

The study also demonstrated that it is feasible to develop a project that is not only effective but can provide a significant cost benefit to the national herd and with limited additional burden to be placed on individual farming businesses.

The programme also has the potential to supply Scotland with a world leading database of maternal DNA proving guaranteed traceability and virtually eliminating fraud from the beef meat sector while also providing farming businesses with a suite of key performance indicators which can allow them to make management decisions that can improve their performance, sustainability, and profitability.

Figure 1. Flow Diagram showing Project Group, Producer Group and Project Partners



Results

A total of 541 Dam DNA samples were collected on-farm using Allflex tissue tags.

- 13 samples did not return data of sufficient quality for parentage analysis, compatible with the finished product parentage SNP panel.
- 7 samples did not return chip data.

Analysis returned a 96.3% success rate

Abattoir Sampling & Maternal Traceability

For maternal traceability, Identigen Ltd extracted the DNA and conducted a DNA TraceBack for primal and diluted minced samples.

Maternity was confirmed for 100 animals from the sample pool of 110, yielding a 90.9% success rate.

The phenotypic data gathered from the breeders and finishers included abattoir data, nutritional data, and health records. Once all the data gathered was assessed the study focussed on 10 breeder and finisher traits detailed below.

Summary of ten production traits in calves of genotyped dams. 'N' shows the number of calves that were phenotyped for that given trait;'h^2' indicates heritability

Trait	N	h2	Top hit	Cromosome	GW P value
First weight	280	0.45	AX-106734619	3	0.360
200D weight	483	0.72	AX-106722404	0	0.935
Weaning weight	437	0.42	AX-115099909	4	0.375
Weaning DLWG	437	0.81	AX-124377692	18	0.700
Sale weight	486	0.28	AX-124386054	7	0.740
Sale DLWG	476	0.64	AX-106733023	6	0.585
Finishing age	286	0.22	AX-106757280	29	0.235
Finishing weight	282	0.44	AX-106722726	8	0.330
Finishing DLWG	282	0.27	AX-185122107	7	0.495
Carcass weight	283	0.54	AX-185122631	8	0.080

Challenges, Successes and Conclusions

Main challenges

During the course of this study, the project team were presented with several challenges. The first of these was the collection of consistent data from farm records (phenotype data). While the farmers often had comprehensive data on farm management, the differences in format and recording styles made the results difficult to compare and contrast.

It should be noted that these difficulties were present where farmers had comprehensive records, if the project was scaled up, there could be further difficulty in collating and comparing such a variety of records.

The project team concluded then, that if data were to be gathered to enhance performance, it would be best if gathered from objective sources.

Another challenge during the study was the circumstances caused by Covid-19. Due to restrictions imposed by the UK and Scottish Governments all on farm data collection, from tagging to collecting farm management information.

In spite of the issues created by Covid-19, working in isolation provided a useful test of the circumstances that producers and administrators would likely encounter were the project scaled up significantly.

Successes

This project set out to establish a number of principles, that could demonstrate the value and potential of maternal DNA to the Scottish beef industry. In that respect QMS and the wider project team, alongside our DNA Strategic Group and Project Partners believe that this proof-of-concept study has clearly and unambiguously demonstrated the principles.

- Assembling the main project group demonstrated that using data could benefit each of the individual businesses involved increase their efficiency and profitability.
- The carcass traceback systems were successful in establishing traceability, and proved that the principles were scalable.
- Data flow from abattoir back to producer provided an effective and simple management tool that producers could use to make decisions.
- The ease and success of the on-farm DNA collection using sampling tags was evident, demonstrating that this project can utilise existing industry practices to gather data at a larger scale.
- The data received by the Moredun Institute for analysis, was of good quality and could be used to begin building genomic maps, to identify the performance traits of animals in more detail, if it were collected on a larger scale.

Conclusions

Q: Can full traceability be achieved through use of maternal DNA?

A: Yes, a full traceability programme could be operated using only maternal DNA

Q: Can farmers take and deliver accurate DNA samples?

A: On-farm DNA collection using sampling tags was carried out extremely well, showing the project was scalable.

Q: Can Accurate Phenotypic data be collected on-farm at a large scale?

A: Phenotypic data proved to be too variable and difficult to compare when gathered on farm, so phenotype data would be better if gathered through objective sources. .

Q: Can maternal DNA be used to drive high performance in the Scottish Beef Industry?

A: Yes, maternal DNA is a tool which can be used to accelerate genetic gain in the Scotch Beef Industry but some “ground truthing” work is required to develop models to fast-track progress.

Q: Is it possible to develop and deliver a full DNA traceability system without placing additional burdens on producers?

A: Yes

Q: Can data transfer be effectively achieved up, down and across the supply chain?

A: The study demonstrated that effective data flow up, down and across the supply chain was not only possible, but less challenging than expected

The potential of harnessing DNA to improve Scotch Beef PGI

Scottish beef farms have immense potential to address the issues that the future holds, and our producers have a variety of ways to help Scotland achieve its emissions targets.

Genetic improvement is one of the most important of these, offering the ability to be more resource efficient, while improving growth, improving feed conversion ratio, and significantly reducing the economic and environmental costs of beef.

In addition to the world leading traceability standards that Scotland could enjoy if this programme were to be scaled up, a range of other benefits could be delivered through genetic enhancement in the long term. These could include more consistent eating quality, reduced use of antibiotics, and enhanced resistance to disease, improving health and welfare of animals within the beef sector.

By embracing the principles established by this project has the potential to deliver significant social and economic benefits. From environmental and sustainability targets to a greater resilience in our rural economies, and communities.

What could a larger scale project look like?

If the concepts established in this study were scaled up and applied, they could help to establish a world leading DNA database, that provides full traceability and complete security throughout the food chain, cementing Scotch Beef as a product with superior marketability.

A larger scale project could also utilise phenotype data to develop real-time management information that Producers could utilise to make management decisions on farm to improve the efficiency of their businesses.

Improvements in efficiency range from; a reduction in calving interval, to number of calves reared per cow. While some of those performance improvements may seem simple, even small improvements to national averages could put significant value back into the Scottish beef industry

The potential of harnessing DNA to improve Scotch Beef PGI

Component	Poetntial improvement	Precentage improvement	Value of improvement
Calving Interval	11 day reduction in calving interval	2.7%	£8,800,000
Calves per cow	Increase number of calves per 100 cows from 82 to 84	2%	£6,400,000
Growth Rate	12 day reduction in finishing time from 650 days down to 638	1.8%	£7,800,000
Feed Conversion	An improvement in feed conversion ratio from 7:1 to 6.86:1	1.4%	£4,000,000
Calf Mortality	Reduce calf mortality from 6% down to 5.88%	2%	£4,100,000
Finishing Grade	0.2 improvement in finished cattle grade		£1,700,000
Fraud	A likely reduction of £2.5 million is possible.	50 – 83%	£2,500,000
Marketability	Traceability will grow consumer confidence		£2,800,000

Conclusion

The Scotch Beef PGI Traceability and Performance Project carried out by QMS and Jonathan Birnie, demonstrates clearly that harnessing the potential of DNA is not only possible, but is achievable for relatively low costs and need not create additional burden for producers.

The potential wins of harnessing this potential are so large that it only takes tiny, fractional improvements to fully justify the cost of the programme. In reality, if the project is effectively designed and implemented, the return will be many multiples of the cost of the programme.

Properly utilising DNA and combining it with phenotypic data to improve traceability and performance presents a genuine opportunity for generational change in the Scottish beef sector and that it will make a significant effort in meeting the climate targets that the Scottish Government has laid out, while also enabling Scottish beef producers to once again be world leaders

Contact

For more information on the Scotch Beef PGI Traceability and Performance Project, or for copies of the more detailed Technical Report do not hesitate to contact QMS:

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