FARMING connect
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Focus Site Project Review

Prepared for

Glangwden and Pencraig GEBV Limousin projects

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1 Summary

Two farms looked at the use of GEBVs in their Limousin herds as their Farming Connect supported Focus Farm projects. Due to the similarity and complementarity of these projects, Farming Connect requested that the results of the projects were presented as one single report.

Glangwden, Trefeglwys, Caersws in mid Wales is run by Chris and Fiona Jerman and comprises a herd of around 80 pedigree Limousin suckler cows producing breeding bulls for sale mainly to commercial producers; breeding females are sold periodically at Welshpool Market. The farm also has a poultry unit of 32,000 layers and large breeding ewe flock.

Young entrants, Thomas and Hannah Price run Pencraig, Trelech in West Wales. They have a herd of 25 pedigree Limousin suckler cows and 500 Texel cross ewes on their 260 acre farm. Thomas uses AI to incorporate the best genetics in the herd. Bulls are sold to other pedigree breeders and also to commercial suckler and dairy herds for breeding.

Both herds carry out performance recording to produce Estimated Breeding Values (EBVS), and wanted to increase their depth of knowledge regarding the use of GEBVs for their pedigree herds, in order to further inform breeding decisions, and provide the businesses with enhanced marketing opportunities for selling breeding stock.

1.1 Focus Farms Project Key Objectives

- To learn about DNA sampling to assess carcase traits merits
- To understand how to use DNA sampling to assess carcase traits merits
- To encourage take up of this technology to attain a commercial advantage
- Understanding how different myostatin variants are expressed in production traits

1.2 Conclusions from both Projects

The use of GEBV (Genomic Estimated Breeding Value) results for the Glangwden and Pencraig herds has resulted in the production of young breeding bulls which can reliably be used to:

- Target specific carcase weight output required by abattoirs
- Reduce the age at slaughter thereby increasing production efficiency and decreasing GHG emissions
- Increase retail value of the carcase by producing more high priced cuts of meat

A myostatin genotype is genetic information associated with 'double muscling' which may help decision making especially with regard to specific matings with the herd, in order to achieve higher levels of kg meat production.

There are three main myostatin (double muscling) variants in the Limousin breed and the presence of single/double copies of specific double muscling variants may lead to undesirable traits being exhibited, such as increased calving difficulties, if not managed properly. This project helped both farm businesses increase their depth of understanding of myostatin variants, and how to manage these without impacting on production, using GEBV information.

Both farms now use GEBVs to select for specific production traits, whilst avoiding undesirable traits such as increased calving difficulties. Results from GEBV testing provides the information required to plan and select the matings of the younger female portion of the herd. This delivers the best outcomes in terms of improving carcase merits whilst also limiting any potential calving difficulties or impacting on milk ability.

1.3 Take home points for the industry

1. The uptake of genomic testing increases the opportunities to respond to future commercial beef sector demands in terms of markets, pricing structure and trading environments.

Work to-date has identified a difference in retail value of around £100-150/carcase between progeny from High GEBV sires and progeny from low GEBV sires[1].

2. Genomic estimated breeding values are available for:

- Carcase weight
- Days to slaughter
- Carcase cuts – silverside, rump, sirloin, topside, knuckle, fillet
- Retail value index

The two main GEBVs that can be clearly linked to producing better returns for the farmer currently are **days to slaughter** and **carcase weight.**

3. **Myostatin variants have benefits in terms of meat yield, feed efficiency and meat quality**. However they must be carefully managed in a population and need to be more widely tested for with results published and discussed openly as the presence of single/double copies of certain variants may lead to increased calving difficulties and a reduction in milking capacity.

4. Carcase traits (muscling and fat cover), calving traits and milk traits in cattle are controlled by **many** genes. It is important to remember that **myostatin is only one gene and as such is not a predictor of an animal's performance.**

5. Consistent, good quality herd management, with good cost control provides the foundation for a profitable beef enterprise. **The use of EBVs and GEBVs helps provide market differentiation and a sound evidence base for sale values, but are not alternatives to good herd management.**

2 Business Review

2.1 Physical benchmarking

Both farms have EBVs (estimated breeding values) available for their cattle. The EBVs are a measure of genetic potential which can be used to assess an animal's breeding merit for a specific trait, and are used as part of the marketing material by Limousin breeders to evidence the breeding value and genetic potential associated with these pedigree animals.

The EBV traits available cover:

- Ease of calving
- Growth and Carcase attributes
- Maternal attributes

The existing EBVs for the focus farms show that both herds:

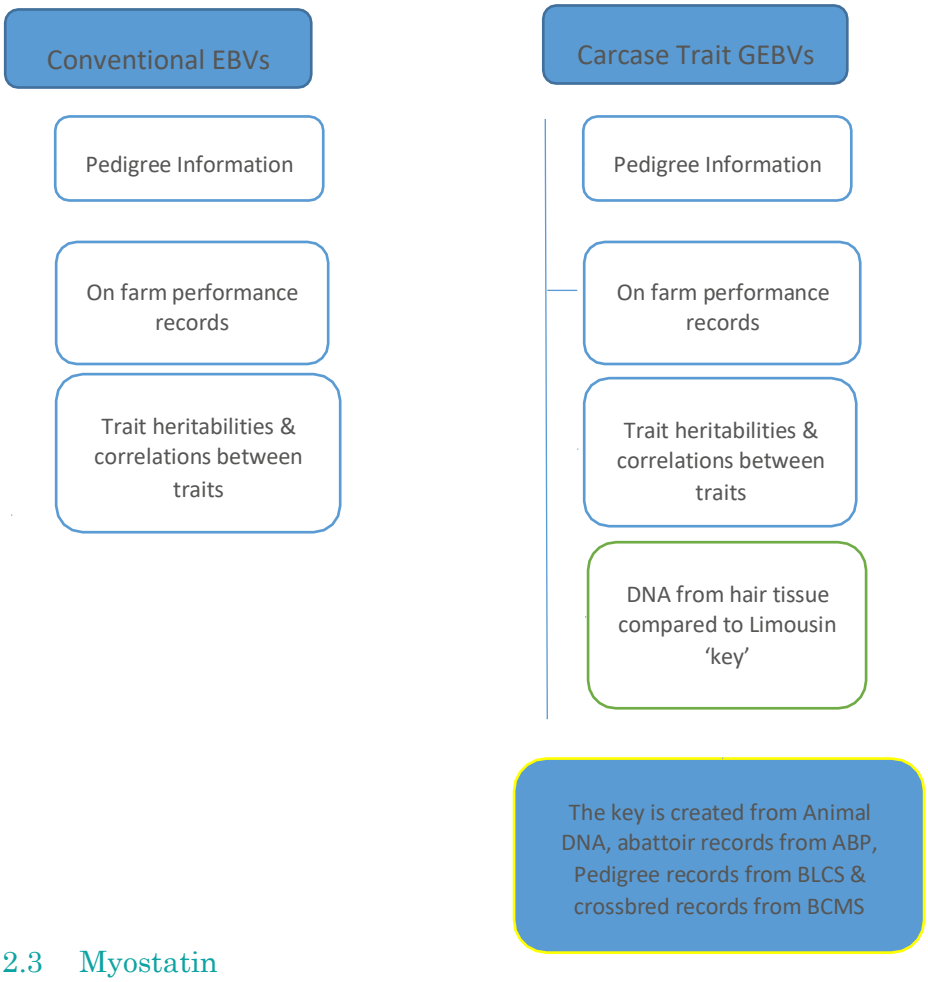
- Have a higher 400 day growth than the breed average
- Better muscle depth than the breed average
- Easier calving (Glangwden),
- Reduced fat depth (Pencraig)

The accuracy of EBVs increases the more datasets are submitted into the 'EBV pot' associated with that breeding parent animal, but cattle (relative to other livestock) take a long time to grow. Therefore an EBV dataset associated with a specific bull may be most useful when the breeding animal has passed its most productive phase of life.

[1] Source Meat Prices Index

Genomic Breeding values take EBVs further by using information from animals' DNA which is then compared to a 'Limousin key'. The 'Limousin key' contains records from commercial herds as well as pedigree herds. Conventional EBVs do not use DNA. One key advantage associated with GEBV is that reliable performance datasets can be compiled much faster for the breeding animal concerned, rather than waiting for progeny to grow and express recordable traits.

2.2 The similarities and differences between EBVs and GEBVs, using carcase trait as an example.



2.3 Myostatin

The three main mutations of the myostatin gene which occur in the Limousin breed are Variant F94L, Variant nt821 and Variant Q204X.

Variant F94L

- Most frequently occurring (94% of the population)
- Increases size of muscle fibres with no associated increase in calving difficulty or lowered fertility or longevity
- Those with two copies of the gene (homozygous) show
  - Increases in primal cuts by up to 19%
  - Overall increases in Retail Beef yield by up to 8%
  - Leading to better rates of feed conversion
  - Better meat quality

Those animals with one copy (heterozygous) also exhibit these characteristics but not to the same degree.

Variant nt821

- Carried by 4% of population
- Recessive i.e. both copies of the gene need to be present for the animal to show the trait
- Those with two copies will show:
    - Reduced fat depths, large rounded rump & thighs
    - Slightly heavier birth weights leading for the potential for more difficult calvings
- If animals have one copy of the gene (heterozygous) with F94L(i.e. F94L/nt821), these animals will be known as carriers and will
    - Exhibit carcase quality characteristics
    - Less likely to be affected by more difficult calving issues

Variant Q204X

- Carried by 1.4% of the population
- Partially dominant
- Those animals with two copies of the gene will exhibit
    - Larger loin depth, reduced fat depth, increased meat tenderness
    - Potential for heavier birth weight, and if females reduced milking ability
- If animals have one copy of the gene with F94L (i.e. F94L/ Q204X) these animals will be known as carriers and will
    - Still exhibit carcase quality characteristics
    - Less likely to be affected by larger birth weights and reduced milking ability

Test results. To avoid repetition, the test results are outlined in full under section 3.2 in the Project Review further on in this report.

2.4 KPIs and attributes

The main KPIs for both projects are

- Days to slaughter
- Carcase weight
- Retail value

The main attribute of myostatin testing is the knowledge of the gene variant present which can be then used to make breeding decisions.

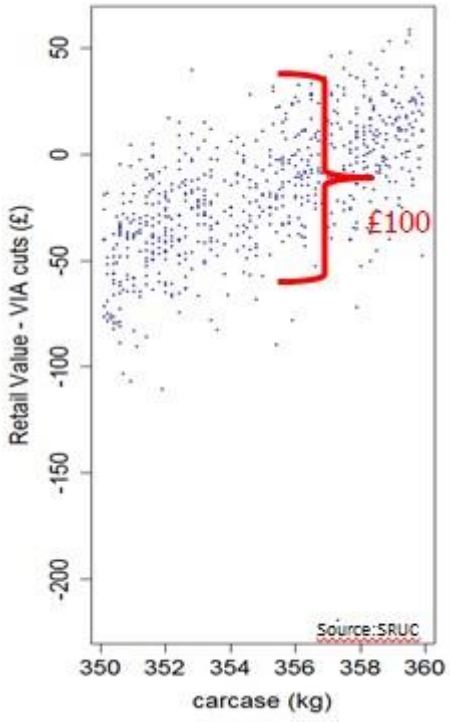
2.5 Potential impact on of the project on the businesses

The potential impact and value of these of the projects on the businesses is to provide further information about cattle which allows the business to make future breeding decisions, and therefore produce better quality breeding stock, with high levels of credibility, resulting in premium prices being achieved for stock sold. Bulls from both these herds are also sold on to be used in other pedigree and commercial beef and dairy herds influencing efficiency of beef production on a wider scale.

2.5.1 GEBVs

The range of GEBVs are extensive, and a breeder can select whichever are closest aligned to their breeding objectives. However days to slaughter and carcase weight GEBVs have a direct association with maximising production on-farm.

Work to-date has identified a difference in retail value of around £100-150/carcase between progeny from High GEBV sires and progeny from low GEBV sires[2].



The graph[3] above was produced from a snapshot of 20,000 Limousin steers in 2015 across the industry. These animals all weighed the same (350-360kg) and graded the same for fat and conformation, and the producers were therefore paid the same. Yet the animals' retail value as measured using Visual Image Analysis (VIA) differed by around £100-£150. The breeding values developed will identify the cattle with the genetics to produce to the top of the graph.

In the future the release of new breeding values for carcase traits will eventually be linked to a more sophisticated VIA payment grid taking into account the animals measurements for individual carcase cuts.

[2] Source Meat Prices Index

[3] Personal communication – Alison Glasgow

2.5.2 Myostatin variants

The benefit of testing for myostatin variants is to provide information on the types of myostatin variant present in the herd.

The presence of the F94L variant presents no problems, however knowledge of the presence of the less frequently occurring nt821 or Q204X means that breeding decisions can be made to limit the negative impact of these genes. The breeder can then plan matings to avoid the potential of increasing calving difficulties (which have a mortality and cost implication), and also -in the case of the Q204X variant- a reduction in milking ability, which can threaten calf health and vigour.

3 Project review

3.1 Aims of the project

- To learn about DNA sampling to assess carcase traits merits
- To understand how to use DNA sampling to assess carcase traits merits
- To encourage take up of this technology to attain a commercial advantage
- Understanding how different myostatin variants are expressed in production traits

The production of Genomic Carcase Traits for the Limousin breed represents the first genomic values available to the beef industry, and a further aim of these projects was to introduce beef breeders to genomic technology and facilitate understanding of its practical use in breeding herds.

3.2 Test results and discussion

About 50 samples from each herd were genotyped to produce GEBVs and determine the myostatin variant present. A hair or semen sample was taken and genotyped by a DNA laboratory. A BLUP run incorporating this DNA information is carried out three times a year and results are reported back to the breeders. The breeder can then decide whether to publish the results for wider industry viewing.

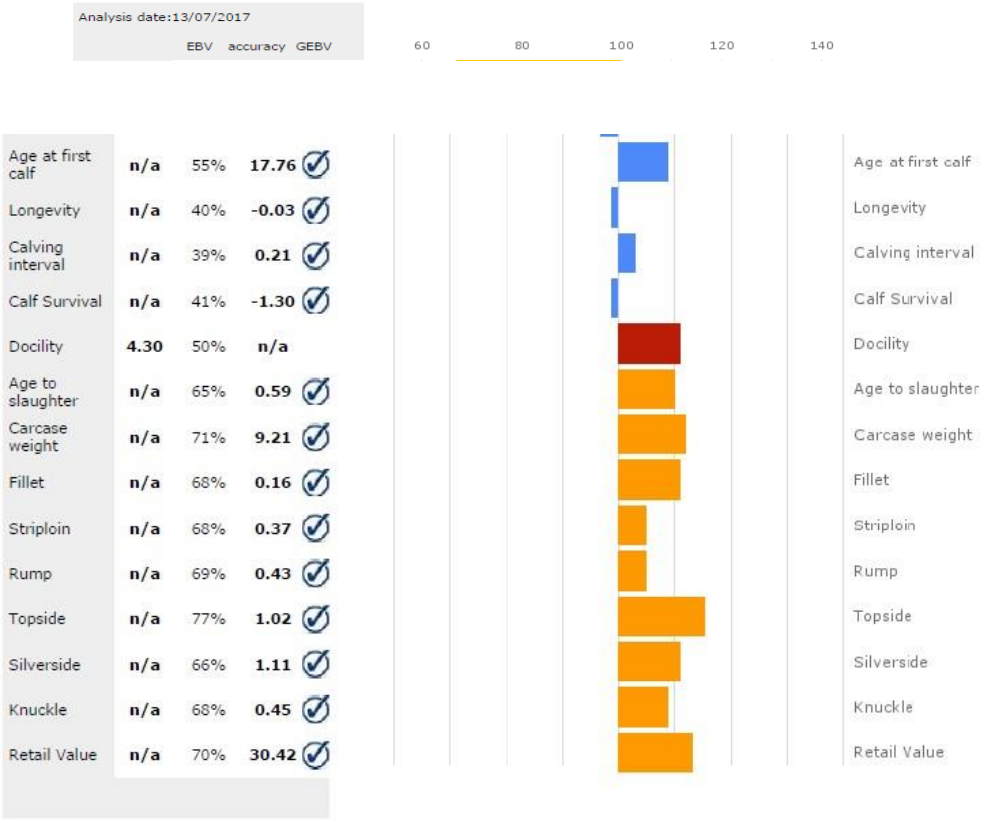
The samples were taken from the following types of animals, and in the following order of selection:

1. Stock bulls
2. Cows that are being flushed and any other VIP cows
3. All 12-24 month old bulls destined for sale as breeding bulls
4. Young heifers where decisions are still to be made about herd retention
5. Bull calves under 12 months old
6. Three year old females
7. Four year old males
8. Females in ascending age up to a maximum of 50 animals sampled

3.2.1 GEBVs

A printout of the results from one of the cattle in the project is shown in Appendix 1[4], providing information on EBVs and also the new GEBVs. The GEBVs section is highlighted overleaf:

[4] As provided by Alison Glasgow, Limousin Cattle Society



The middle line represents the breed average for all traits (100). Figures which lie to the right of the of the centre line indicate the GEBV is above the breed average. The further to the right the further above the breed average.

Bars which are to the left are below the breed average. Again the further to the left the further below the breed average it is.

In the example above, a beef animal with a carcase weight of 9.21Kg has the potential to pass on an additional 4.60kg kg of its carcase weight to its progeny when compared to animal with a GEBV of 0KG. As with EBVs, the Dam's GEBV is halved when deciding what she will pass on, since 50% of the calves' genes will come from the sire.

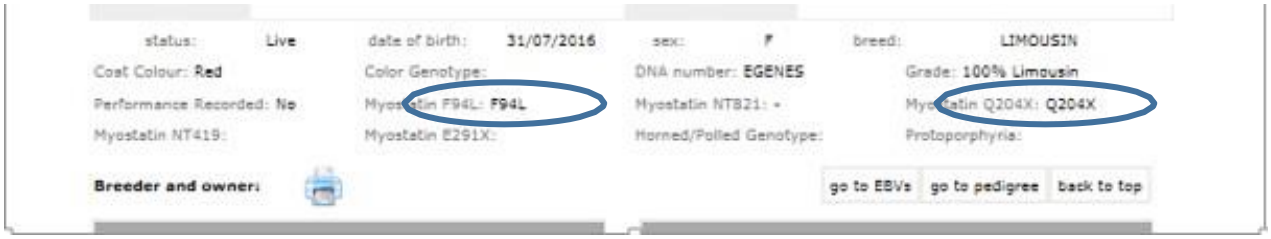
GEBV trait definitions are slightly different to EBVs. The standard slaughter age used in the GEBV calculation is 600 days. The conventional EBVs for growth, muscle and backfat is recorded at 400 days. Research has shown that as time between the measurements increases the genetic relationship between them decreases.

This means that the relationships between 400 day weight EBV and Carcase weight GEBV, and the muscle/backfat EBVs and the carcase trait GEBVs are moderate. For example, there are animals with favourable 400 day EBVs and favourable carcase weight GEBVs but there are also animals with favourable 400 day EBVs and unfavourable carcase weights. The 400 day EBV and the carcase weight GEBV are actually different traits.

3.2.2 Myostatin results

Myostatin is a gene which influences the production of a protein which controls muscle development. Natural mutations of the gene produce proteins that are less effective at controlling muscle development, which

results in increased muscle mass. There are three main mutations which occur within the Limousin breed (as well as other breeds) -F94L, nt821 and Q204X. An example of a myostatin genotyping is shown below:



GLANGWDEN MARVIN

UK 701298/101378 DoB: 22/04/2016 DNA No.: B626357

GENOTYPING RESULTS:

Analysis	Result	Date of Analysis
MYOSTATIN_F94L	F94L/F94L	13/02/2017
MYOSTATIN_NT821		13/02/2017
MYOSTATIN_Q204X	-	13/02/2017

The two genes which make up the animals genotype are shown above. When this animal is mated with another, half the genes from each of the dam and sire are passed on.

The table below shows the possible genetic combinations that could arise of using a F94L/Q204X sire on a F94L/F94L female and then crossing one of the progeny, a Q204X carrier with another Q204X carrier.

	DAM A	
SIRE A	F94L	F94L
F94L	F94L/F94L	F94L/F94L
Q204X	F94L/Q204X	F94L/Q204X

	DAM, progeny of sire and Dam A	
SIRE B	**F94L**	**Q204X**
F94L	F94L/F94L	F94L/Q204X
Q204X	F94L/Q204X	Q204X/Q204X

There is a 25% chance that the progeny of the second crossing will carry double copy of the Q204X gene which although leads to good carcase characteristics, can lead to heavier birth weights resulting in calving difficulties and dams with less milk.

This over several generations can compound if carrier animals and or animals with double copies of the genes associated with heavier birth weights are mated.

The availability of the myostatin variation provides information so that matings can be planned to deliver the best outcome for the herd. Without the GEBV DNA information, a breeder would have no knowledge of whether undesirable crosses are occurring, as these traits are not ones that can be quickly, visually or physically assessed by the breeder. Only DNA testing can provide the information required in order to make

pre-emptive breeding decisions, minimising the cost associated with propagating undesirable traits across the pedigree beef industry.

3.2.3 SWOT project analysis

STRENGTHS	• Genotypes can be obtained shortly after birth, thereby enhancing the accuracies of genetic merit predictions quicker than performance recording alone, allowing for faster genetic improvement. • DNA and abattoir records come from independent sources representing a move away from breeders' own records • All owners of Limousin- bred cattle can gain GEBVs. To gain a GEBV all that is required is the DNA sample (from blood, hair, or tissue sample) and identity of the animal • Myostatin genotyping in double muscled cattle can help make decisions in relation to specific matings within the herd, thereby avoiding potential calves with heavier birth weight and dams with lowered milk production.
WEAK-NESSES	• At present the abattoir payment system does not reward for the superior carcase information provided by the GEBVs • Only certain breeds offer GEBV testing. A reasonable number of samples are required (usually from several thousand animals within a breed) to attain accuracy
OPPORTUN-ITIES	• For other breeds to use DNA sampling to produce GEBVs and for specific breeds, information on myostatin variants • To link the new breeding values for carcase traits to a more sophisticated VIA payment grid taking into account the animals measurements • To use DNA sampling to allow commercial producers significant opportunity in assessing current and future sires to improve carcase output and reduce age to slaughter
THREATS	• Failure to move the quality of carcases and improve the profitability of the industry may make it difficult to compete with global markets in the future • Failure to test double muscled cattle for myostatin variants may result in breeding decisions which lead to increased calving difficulties and dams with lowered milk production

3.2.4 Alignment to sector's strategic goals

This work contributes to the Welsh Red Meat Sector's strategic objectives, specifically in relation to:

1. Increasing number of carcases meeting standard market requirements
2. Improving production efficiency and its relevance in delivering climate change targets
3. Increasing the national average cattle performance
4. Informing/ educating producers, about maximising carcase utilisation and producing a product that meets the specific needs of the market

4 Impact on the industry

4.1 Impact on the individual businesses

For the full summary list of the impact of the project on these businesses, refer to the Project Conclusions box in the Summary section of this report.

The two focus farms are already using the results produced by GEBVs and genotyping for myostatin variants to determine future sire and dam selection and improve further the quality of their breeding stock and progeny.

4.2 Impact on wider industry

Take home points for the industry from the work at Glangwden and Pencraig are as follows (also provided in the Summary section of this report).

They include the following:

Work to date has identified a difference in retail value of around £100 -£150 per carcase (source meat price index) between progeny from a high GEBV sire and a low GEBV sire.

The release of new breeding values for carcase traits will eventually be linked to a more sophisticated VIA payment grid taking into account the animal's measurements.

The advantages of GEBVs over EBVs are:

DNA and abattoir records come from independent sources

Speed- GEBVs can be obtained shortly after a calf is born

Improved accuracy of low heritability traits/ traits that are difficult to record

Lower Cost- Accuracies are enhanced quicker using genome –wide selection compared to collecting records on farm

The uptake of genomic testing increases the opportunities to respond to future commercial beef sector demands in terms of markets, pricing structures and trading environments.

Genomic Values are in development for the following traits:

Traits	
Production Traits	Feed efficiency, Meat quality
Functional Traits	Female fertility, calf survival, Efficiency& fitness characteristics, calving
Disease traits	TB, Johnes

Not all animals GEBVs reflect their current EBVs. Thus the interpretation of GEBVs needs to be properly explained to the industry to ensure that the values are fully understood.

4.3 Impact on Welsh Government's cross cutting and priority themes

4.3.1 Climate change

Improving production efficiency through selecting for age to slaughter and carcase weight will reduce greenhouse gas emissions especially as more animals will finish quicker.

4.3.2 Animal Health and Welfare (AHW)

Genotyping for myostatin will allow breeding decisions to be made which will minimise the impact of nt821 and Q204X myostatin variants on calving difficulty and facilitate the production of more females with good maternal characteristics.

4.3.3 Future Generations

This project encourages technology uptake, which leads to enhanced breed data and will result in more efficient cows and improved quality finished animals. The use of genotyping for a beef business shows innovation, and is a good take home message for the beef industry.

Running the herd more efficiently, and producing finished animals with more suiting the market requirements should lead to better returns and future sustainability. This will provide a business that can be passed onto future generations.

4.3.4 Tackling Poverty

Producing more efficient cows will improve returns. The ability to improve farm incomes, or develop alternative incomes, as outlined previously, fits well with the Welsh Government themes. With the advent of Brexit the ability to access secure profitable markets long term for a Welsh Beef product is not clear. This uncertainty provides an additional drive for beef producers to run as resilient a business as possible, maximising herd performance, minimising costs, and releasing time for additional income generation activities

4.3.5 New Entrants

Young entrants Thomas and Hannah Price have adopted this technology and are using the technology to drive their business forward.

Appendix 1 EBV and GEBV table from one of the heifers involved in the project

status: Live | date of birth: 31/07/2016 | sex: F | breed: LIMOUSIN | coat colour: Red

Analysis date:13/07/2017

	EBV	accuracy	GEBV
Birth weight	4.40	57%	n/a
Calving Ease	-5.80	58%	n/a
Maternal Calving Ease	-0.30	45%	n/a
Gestation Length	3.90	70%	n/a
Calving Value	-5.00	68%	n/a
200 Day Growth	21.00	56%	n/a
400 Day Growth	41.00	56%	n/a
Muscle Depth	3.60	52%	n/a
Fat Depth	-0.20	48%	n/a
Beef Value	23.00	57%	n/a
Scrotal Circumference	-0.20	52%	n/a
200 Day Milk	-1.00	39%	n/a
Age at first calf	n/a	55%	17.76
Longevity	n/a	40%	-0.03
Calving interval	n/a	39%	0.21
Calf Survival	n/a	41%	-1.30
Docility	4.30	50%	n/a
Age to slaughter	n/a	65%	0.59
Carcase weight	n/a	71%	9.21
Fillet	n/a	68%	0.16
Striploin	n/a	68%	0.37
Rump	n/a	69%	0.43
Topside	n/a	77%	1.02
Silverside	n/a	66%	1.11
Knuckle	n/a	68%	0.45
Retail Value	n/a	70%	30.42