Signet
BREEDING SERVICES

THE NATIONAL TERMINAL SIRE EVALUATION

CONTENTS

A MORE INFORMATIVE, MORE FREQUENT AND MORE COMMERCIALLY FOCUSED BREEDING EVALUATION FROM SIGNET BREEDING SERVICES.

A NEW EVALUATION FOR TERMINAL SIRES

ACHIEVEMENTS THROUGH SELECTIVE BREEDING

In the 25 years since the introduction of across-flock evaluations, more than 3 million terminal sire sheep records have been analysed by Signet Breeding Services. This analysis has been carried out by using a dataset of over 650,000 ultrasound scans for muscle and fat depth, and over 10,000 images from computed tomography (CT).

The UK breeds sheep with world-leading terminal sire genetics and has some of the best tools for measuring and analysing sheep in the world.

1970/80s	Ewe recording schemes
Late 1980s	BLUP analyses Ultrasound scanning
1990s	Sire Reference Scheme Measures of connectedness
2000s	CT Scanning FEC Whole Breed Analysis Genetic Groups Better Returns Programme
2010s	Measuring new CT traits EID and electronic data uploads Online data entry Inbreeding software RamCompare DNA storage and early genomic work

Through levy-funded research and service delivery, the UK has developed world-leading approaches to the recording of sheep for meat and maternal characteristics.

Since 2010, the genetic gain across terminal sire breeds has enhanced the genes that influence growth to scanning age by 5 kg, with similar gains in muscling across the loin and overall meat yield in the carcase.

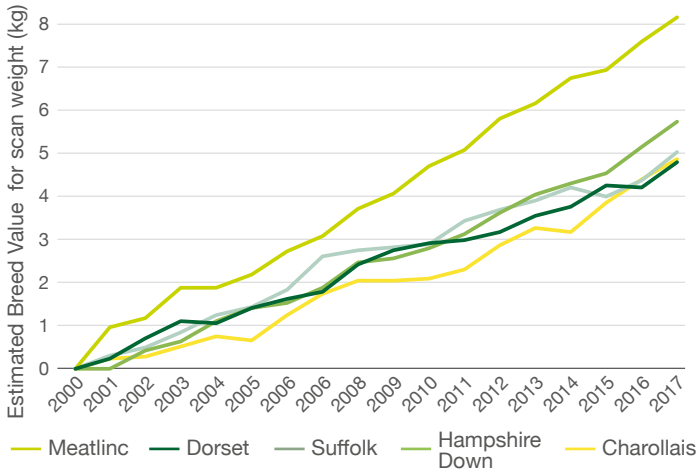

Figure 1. Genetic gain in scan weight EBV in weight recorded lambs since 2000

The average Signet-recorded terminal sire has the genetic potential to be 5 kg heavier at scanning time compared with 2000.

Figure 2. Meatlinc sheep being scanned in the 1980s

Using existing technology, the value of genetic improvement to the UK sheep industry is estimated to be worth £10.7 million per annum (Abacus Review, 2015). The development of a new, more commercially focused approach and a greater uptake of Signet recording in pedigree flocks will see increased benefits.

Taking Charollais sheep as an example, the Top 10% of weight-recorded lambs in 1990 would now be equivalent to the bottom 10% of the breed in 2018.

This is a radical change in the genetic merit of a population.

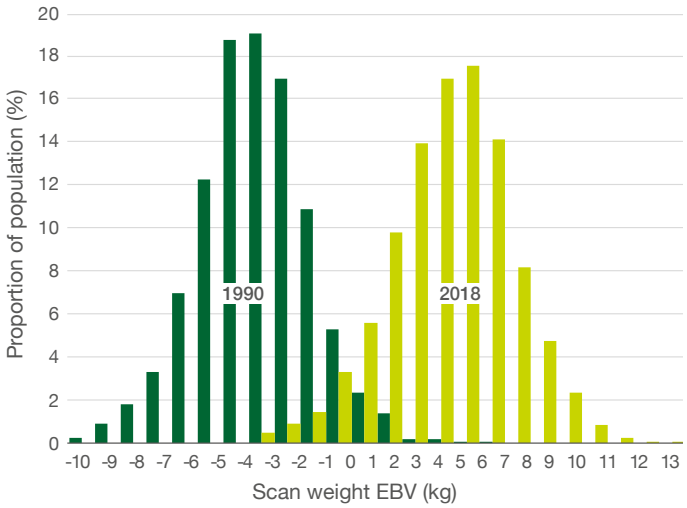

Figure 3. Genetic change in Signet recorded Charollais sheep for scan weight EBV

ENHANCING GENETIC ANALYSES

Knowledge gained from AHDB Beef & Lamb-funded research, and enhancements in computing power have enabled Signet Breeding Services to update the performance recording services delivered to terminal sire breeders, developing a new multi-breed approach to genetic analyses: the 'National Terminal Sire Evaluation'

Benefits of the National Terminal Sire Evaluation

A series of enhancements will be delivered through the new evaluation; these include:

- Enhancing existing Estimated Breeding Values (EBVs) to make them more commercially focused
- Rebasing EBVs to aid interpretation by commercial farmers
- More regular BLUP runs
- Eight new EBVs derived from CT scanning images
- A more accurate assessment of crossbred animals
- Enabling lambs in different flocks that are managed together on the same farm to be analysed together as a single contemporary group
- The integration of RamCompare data, to provide:
  - A greater ability to compare rams, regardless of breed
  - EBVs derived from abattoir data, including carcase weight, conformation, fat class and days to slaughter

Figure 4. Charollais ram, Logie Durno Navigator, owned by the Crogham and Cold Harbour Charollais flocks

WHY USE A MULTI-BREED APPROACH?

In the new analysis, all terminal sire breeds and their crossbred progeny will be evaluated together in a single BLUP run, but results for each breed will be reported individually.

The approach mirrors that used in sheep evaluations in New Zealand, Australia and America, where multi-breed analyses are routinely undertaken. It is the approach used for UK dairy evaluations in which Holstein, Jersey and Friesian cattle are analysed together, but their breeding values are reported separately.

MORE REGULAR BLUP RUNS

The new approach enables evaluations to be run more regularly. In 2019, Signet plans to deliver a monthly genetic evaluation for terminal sire breeds, with data available within 10 working days of the published deadline. This compares with the two or three breed-specific evaluations produced each year, at present.

WHICH BREEDS ARE CURRENTLY INVOLVED?

This multi-breed analysis includes the numerically large terminal sire breeds: Suffolk, Charollais, Texel, Dorset, Meatlinc, Hampshire Down, Beltex, Blue Texel, Bleu du Maine, Vendeen, Shropshire, Southdown. Signet will look at ways to include other breeds in the future.

REBASING EBVs

All EBVs will be 'rebased', meaning an animal's EBVs will now be expressed relative to the average performance of the breed in 2010, rather than subsets of animals recorded in the 1990s.

This update will create a series of breeding values that are more relevant and easier to interpret by the commercial ram buyer.

EBVs are still breed-specific and need to be interpreted relative to the Breed Benchmark, a table showing the Top 25% and Top 10% EBVs within a breed, which will continue to be updated annually.

This chart, which is based on real data, shows how the genetic base has moved up to take into account genetic change within a population.

Figure 5. Rams of different breeds selected for the RamCompare project

Figure 6. Southdown stock ram, East Dean Dean

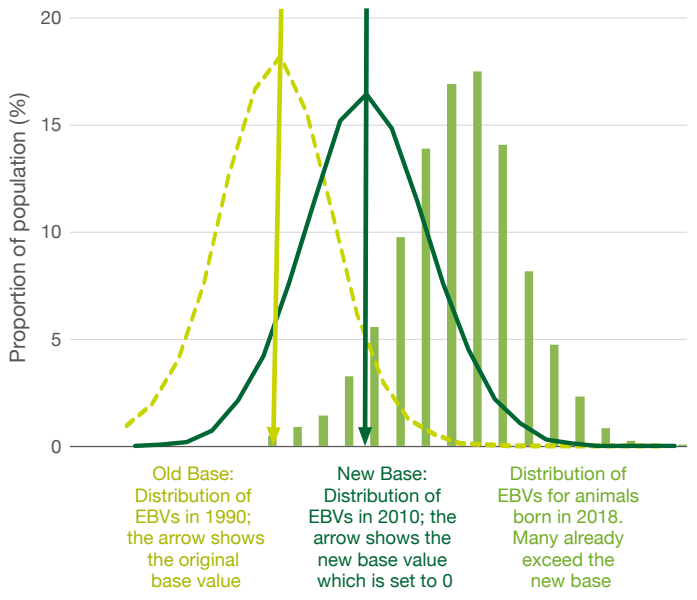

Figure 7. How a base change influences the expression of EBVs

NEW APPROACHES TO ASSESSING MUSCLE AND FAT

The UK sheep industry pioneered the use of ultrasound scanning technology to assess muscle and fat levels across the loin.

Historically, traits such as muscle depth have been adjusted for age within the analysis to identify those lambs that will lay down the most muscle at a certain age, regardless of weight.

Sheep with high Muscle Depth EBVs, might achieve them in two ways:

- Being big, as genetically bigger sheep tend to have more muscle
- Having a high muscle depth, relative to their weight

However, breeders can already select for growth rate using the Scan Weight EBV, and a better approach is needed to assess muscling independently from growth, i.e. the ability to compare levels of muscling at a fixed weight, rather than a fixed age.

Within the new analysis, all carcase traits: Muscle Depth, Fat Depth, CT Lean Weight, CT Fat Weight and CT Gigot Muscularity, will be weight-adjusted, rather than age-adjusted.

COMMERCIAL CONTEXT

The new approach is advantageous for commercial farmers because lambs tend to be drawn on their weight (and finish), not their age. Commercial farmers want lambs with the right amount of muscle and fat (finish) at a set weight, i.e, 40 kg liveweight, not a set age, and the new EBVs help achieve this.

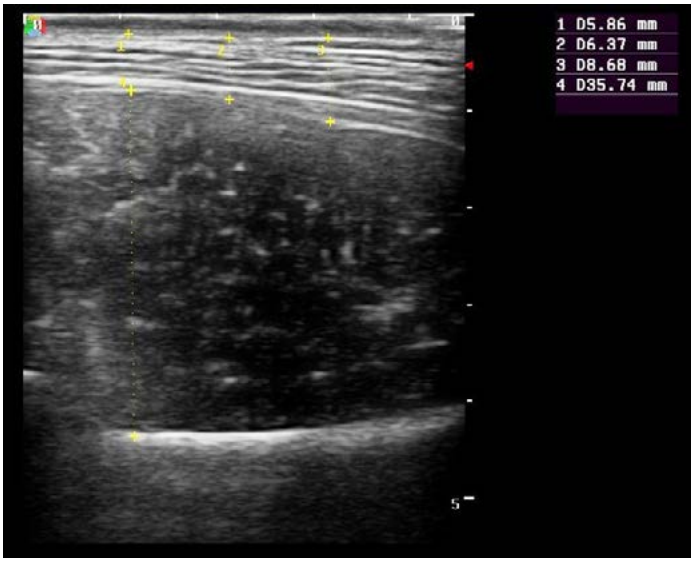

Figure 8. Ultrasound image showing the three points where fat depth is measured and muscle depth at the deepest point

IMPLICATIONS FOR BREEDERS

AHDB Beef & Lamb-funded work by Janet Roden has shown that selecting for age-adjusted muscle depth has enhanced muscling at a fixed liveweight, but the new approach will enable faster genetic gain. Breeders selecting sheep on weight-adjusted EBVs will select different sheep from those selected using age-adjusted EBVs and the ranking of sheep within evaluations will change.

Breeders will benefit from the fact that weight-adjusted traits tend to be more heritable than age-adjusted traits. However, they also tend to show less genetic variation, therefore the scale of the new EBVs will be smaller as a result.

When selecting for weight-adjusted traits, breeders should be aware there can be a negative relationship between the amount of muscle and fat within the carcase. With weight-adjusted traits, the size of the animal is assumed to be 'fixed' so if it has more muscle, it tends to have less fat and vice versa. This explains why some of the gains made in the amount of muscle in the carcase in recent years have resulted in a reduction in the amount of fat in the carcase, when expressed at a fixed weight.

Figure 9. Assessing muscle and fat depth across the loin using ultrasound scanning

CASE STUDY: THE CHAROLLAIS BREED

These charts show the difference between the old and new approaches to assessing ultrasound muscle depth measurements.

Figure 10 shows that in the past we selected those lambs with the best muscle at a certain age. However, there is little real relationship between muscle depth and age. The biggest lambs tend to have the biggest muscles and these were the ones selected using this approach.

Figure 11 shows that much of the variation observed in muscle depth is actually due to liveweight. The new selected group are those with superior muscling, regardless of their weight at scanning.

This doesn't mean weight is no longer important (far from it), but it does mean breeders can now select for superior muscling attributes independently from their growth characteristics.

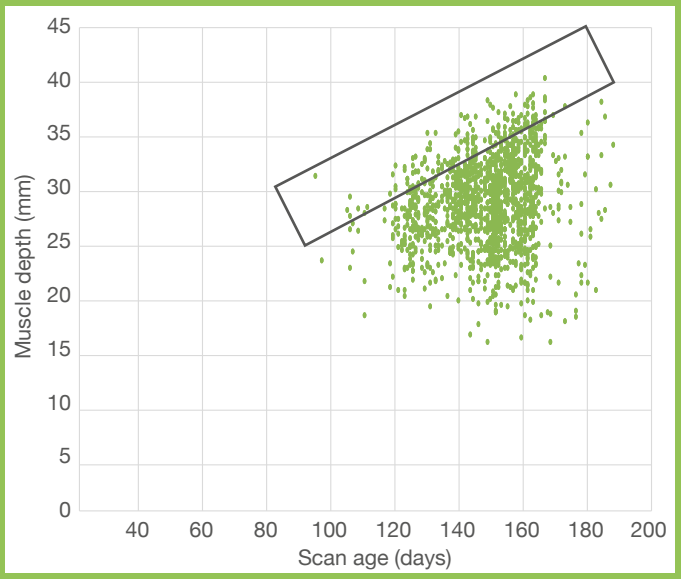

Figure 10. Relationship between muscle depth and scan age in Charollais ram lambs born in 2016

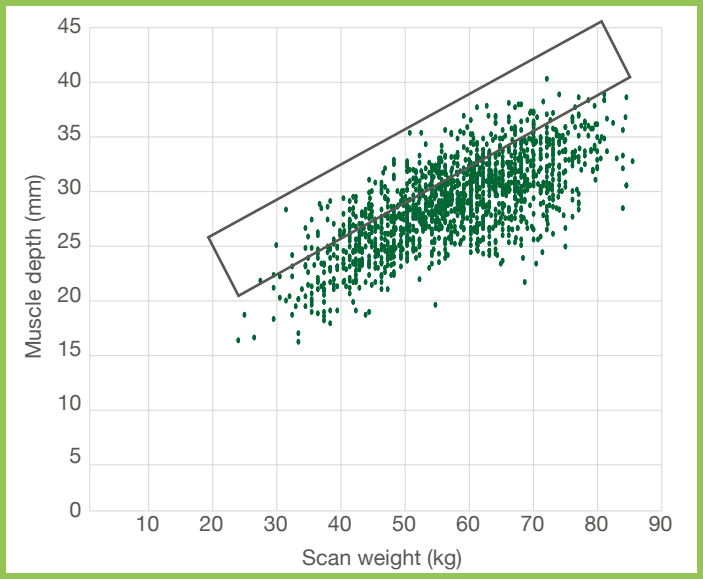

Figure 11. Relationship between muscle depth and scan weight in Charollais ram lambs born in 2016

Which ram has better muscle depth?

These are the Muscle Depth EBVs using an adjustment for age

	Scan Weight EBV	Age adjusted Muscle Depth EBV
Ram A	9 kg	4.2 mm
Ram B	5 kg	3.8 mm
Ram C	5 kg	2.0 mm

These are the Muscle Depth EBVs using an adjustment for weight

	Scan Weight EBV	Weight adjusted Muscle Depth EBV
Ram A	9 kg	2.8 mm
Ram B	5 kg	3.3 mm
Ram C	5 kg	1.5mm

Using age-adjusted Muscle Depth EBVs, Ram A would be deemed to have the best muscled progeny at a fixed age.

However, weight-adjusted Muscle Depth EBVs indicate that Ram B would have progeny with better muscling at a fixed weight (although the lower Scan Weight EBV indicates they may take longer to get there).

Ram C has poorer genes for muscling, regardless of the method of analysis.

Figure 12. Charollais stock rams

HOW DIFFERENT ARE THE RESULTS?

Breeders and ram buyers will be interested to know how the new EBVs compare with those produced in the past. Table 1 shows how the EBVs using the old and new approaches relate to each other.

Estimates for scan weight are virtually unchanged, with a correlation approaching 1. The ranking of sheep for muscle and fat depth are similar, indicating that selecting animals using age-adjusted EBVs has also selected animals with superior muscling attributes at a fixed weight.

The CT traits are more markedly changed, indicating the potential of the new EBVs to do a better job at predicting yield of lean meat in the carcase at a fixed weight.

The low relationship for the prediction of fat weight in the carcase is to be expected. In the past, it was observed that the biggest, fastest-growing sheep often had more fat in the carcase (due to their size), but, as seen with Hampshire Down sheep, those animals also tend to have less fat as a proportion of their weight. Faster-growing animals tend to be leaner at a fixed weight than slower growing animals.

IMPLICATIONS FOR BREEDING INDEXES

Although the way in which EBVs such as muscle and fat depth are expressed will change, it does not mean the aim of terminal sire breeding to produce fast-growing, well-fleshed lambs with optimum levels of finish has changed. Index weightings will change to ensure this overarching breeding objective is achieved.

Table 1. The correlation between EBVs obtained for 2016 born animals using the old and new approaches

	Scan Weight	Muscle Depth (age vs wt)	Fat Depth (age vs wt)	Lean Weight (age vs wt)	Fat Weight (age vs wt)	Gigot (age vs wt)
Meatlinc	0.88	0.82	0.78	0.50	0.38	0.62
Charollais	0.95	0.83	0.83	0.58	0.16	0.79
Hampshire Down	0.94	0.72	0.69	0.55	-0.09	0.68
Suffolk	0.87	0.83	0.75	0.53	0.15	0.55

NEW BREEDING VALUES FROM COMPUTED TOMOGRAPHY (CT) SCANNING

Over the last 20 years, more than 10,000 lambs have been CT scanned. During this time, additional measurements have been taken and through AHDB Beef & Lamb-funded research these can now be evaluated.

The new EBVs are as follows:

- Thoracic spine length
- Thoracic vertebrae number
- Lumbar spine length
- Lumbar vertebrae number
- Total spine length
- Total vertebrae number
- CT-predicted intramuscular fat (IMF)
- CT eye muscle area

Spinal traits tend to have a low to moderate heritability, with levels of genetic variation varying between breeds. It is thought that enhancing spinal characteristics could markedly increase the proportion of saleable meat in high value areas within the carcase.

CT-predicted intramuscular fat (IMF) is determined from tissue densities observed at CT scanning, which are known to predict levels of IMF within the loin and have an impact on meat eating quality.

CT eye muscle area is being evaluated, as breeders are always interested in muscling across the loin and it is recognised that the area is difficult to assess using ultrasound scanning. This new trait will enable breeders to make faster genetic progress in this area.

For more information about CT scanning your sheep, contact the CT unit based in Edinburgh: Kirsty McLean Tel: 0131 535 3251 or **CTUnit@sruc.ac.uk**

Figure 13. SRUC staff loading a lamb into the CT scanner

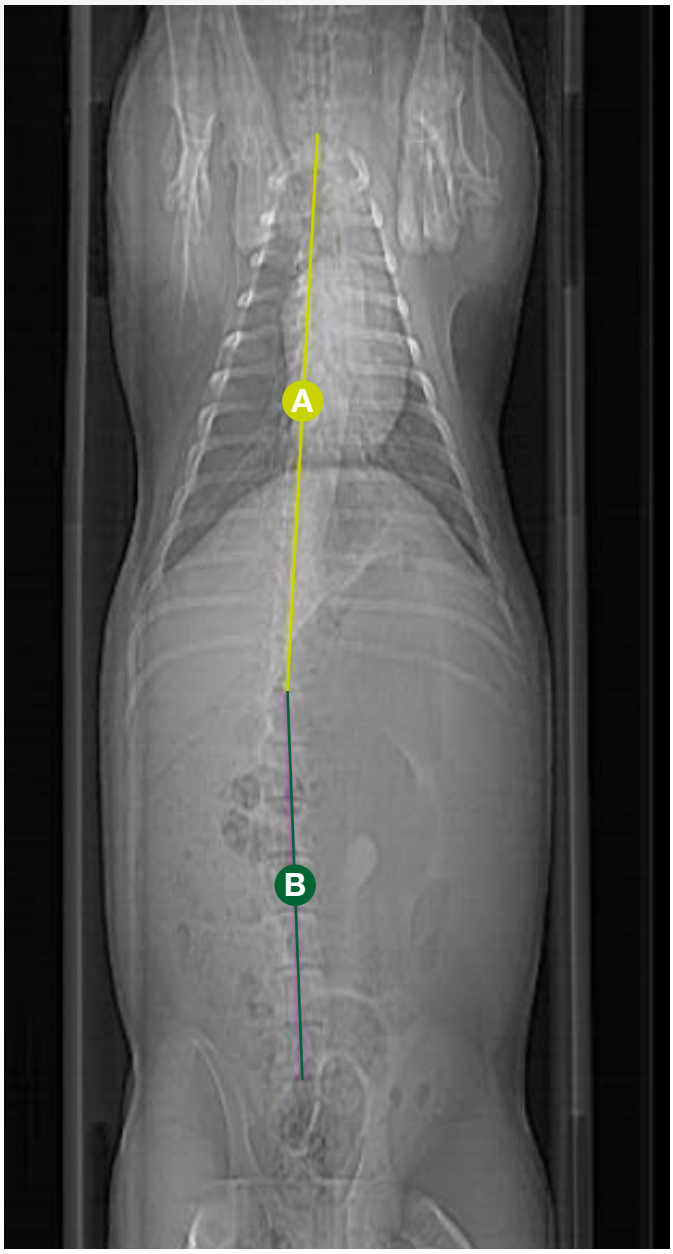

Figure 14. CT image showing thoracic and lumbar measurements along the spine, (A) Thorax (rib) region, (B) Lumbar region

Figure 15. CT image taken through the gigot

ENHANCEMENTS TO EXISTING BREEDING VALUES

LAMBING EASE AND BIRTH WEIGHT

Lambing Ease and Birth Weight EBVs will be available to all breeds.

To get accurate Lambing Ease and Birth Weight EBVs, clients must:

- Weigh lambs immediately after birth and report weights to the nearest 0.1 kg
- Submit both a birth weight and a lambing ease score to get a Lambing Ease EBV

New online publication standards will be established. Only sheep with accuracy values above an agreed threshold will have EBVs published online.

A separate publication is available that explains the interpretation and recording of these traits.

LITTER SIZE BORN AND REARED

Breeders will have two breeding values available for assessing prolificacy, litter size born (LSB) and litter size reared (LSR). The latter trait is new for terminal sire breeders and takes into account whether the progeny by rams used in recorded flocks have been weighed later in life (i.e. survived).

MATERNAL ABILITY

Reviewing the way the Maternal Ability EBV has been evaluated in terminal sire breeding programmes in the past indicates little consensus on the strength of genetic relationships between maternal ability and growth or carcase traits. In the new analysis, the Maternal Ability EBV, which is the genetic component that relates to a ewe's milking ability and maternal care, will be analysed as a standalone trait without any genetic correlations fitted to other traits.

Figure 16. New EBVs will enhance lamb survival by reducing lambing difficulties

FAECAL EGG COUNT

In recent years, relatively few breeders have assessed lambs for faecal egg count (FEC), and the EBVs produced in the past were heavily influenced by correlations to other traits. Given the current level of recording FEC, the decision has been made to make these traits stand alone within the analysis, solely influenced by measures of the trait and not correlated traits.

The Combined FEC EBV is now reported to show its two component parts, FEC S (strongyles) and FEC N (nematodes). New publication standards have been developed, and animals with EBVs below a certain accuracy value will not have EBVs published online.

Figure 17. Lambs waiting to be sampled for faecal egg count

HOW ARE EBVS CALCULATED IN THE NEW ANALYSIS?

The statistical approach to EBV calculation of analysing pedigree and performance data to tease out genetic and non-genetic influences on performance remains unchanged. However, the genetic information that underpins the production of EBVs, such as heritability values and genetic correlation between traits, is being updated.

Months of AHDB-funded research at Scotland's Rural College (SRUC) has been undertaken to produce a set of robust genetic parameters for use within the UK's first multi-breed sheep analysis.

HERITABILITY VALUES

The heritability of a trait indicates how much of the variation between animals can be explained by their genes. High heritability traits are easier to change over time, low heritability traits are more reliant on performance data provided by ancestors.

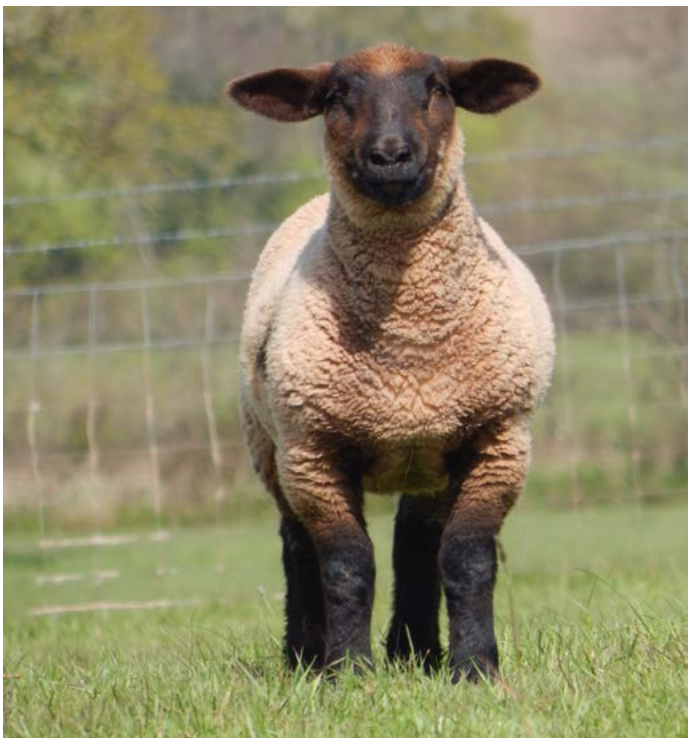

Figure 18. Crossbred lamb sired by a high index ram

GENETIC CORRELATIONS

The genetic correlations observed between traits have also been updated to incorporate information from the most recent research and to take into account changes in trait expression where EBVs have changed from being age-adjusted to weight-adjusted.

HYBRID VIGOUR

Hybrid vigour is included within the analysis and this is taken into account in the analysis of crossbred animals. In general, the impact on carcase traits was found to be small.

Table 2. The latest heritability values based on work by Ann Mclean at SRUC (2018)

Growth and carcase traits	Heritability
Eight-Week Weight	0.15
Scan Weight	0.46
Muscle Depth	0.41
Fat Depth	0.46
CT Fat Weight	0.47
CT Muscle Weight	0.56
CT Gigot Muscularity	0.31
CT Eye Muscle Depth (Unpublished)	0.38
CT Eye Muscle Area	0.41
Spine Length (Thoracic region)	0.49
Vertebrae Number (Thoracic region)	0.44
Spine Length (Lumbar region)	0.20
Vertebrae Number (Lumbar region)	0.12
Spine Length (Total)	0.48
Vertebrae Number (Total)	0.48
CT Predicted IMF (%)	0.38

Other traits	Heritability
Birth Weight	0.15
Lambing Ease	0.06
Maternal Ability	0.10
Litter Size Born	0.16
Litter Size Reared	0.17
Faecal Egg Count Strongyles (FEC S)	0.22
Faecal Egg Count Nematodirus (FEC N)	0.07
Mature Size (Shearling ewe weight)	0.59

Please note the growth and carcase traits are weight-adjusted, rather than age-adjusted.

GENETIC GROUPS

Historically, many of the breed analyses used 'genetic group' solutions that brought animals with unknown parentage into the analysis with different starting points, dependent on their age. However, in recent years, the value of these groups has diminished as Signet has gained access to deeper pedigrees. Today, genetic group solutions have been greatly simplified and, for this reason, breeders/societies are encouraged to provide the fullest possible pedigree for new animals entering the analysis.

DETERMINING BREED AND REPORTING EBVS FOR CROSSBREDS

A new process has been developed to look at the complete back pedigree of an animal to determine breed. For most purebreds, this is straightforward and the analysis determines them to be 100% of a specific breed.

For crossbred animals, the analysis identifies the breed of the animal's ancestors and uses this to determine the breed make-up. This is referred to as the PEB value or 'Percentage of Breed'.

From the PEB values, a dominant breed is determined. Animals will have their EBVs and indexes reported, relative to their dominant breed. In the case of a 50:50 animal, the dominant breed will be the breed of the sire.

When EBVs are converted onto a breed-specific base, this information will be used to determine whether a 'Sufftex' for example, has its EBVs expressed as a Suffolk or a Texel.

FINDING AND INTERPRETING INFORMATION

Information continues to be hosted online at **www.signetfbc.co.uk** where lists of leading sires and ram lambs are made publically available. Online search facilities are still available and the presentation within breeding charts remains largely unchanged.

The main change is in the interpretation of EBVs; a ram with a Scan Weight EBV of +4 kg now means it has the breeding potential to be 4 kg heavier than the average terminal sire in 2010, rather than relative to lambs of its own breed back in the 1990s.

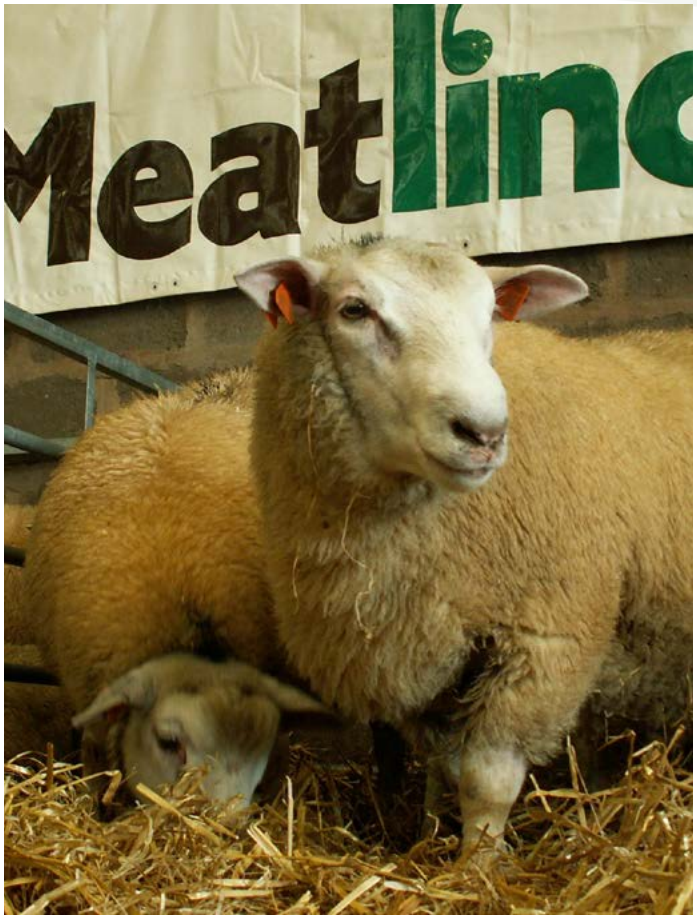

Figure 19. Meatlinc sheep (above and below) have been performance recorded since the 1970's

COMPARING PERFORMANCE

The principles established in 1990 when comparing EBVs for sheep reared in different flocks are as true today as ever. To enable comparison between flocks, there needs to be genetic linkage, i.e. some common genetics used between the flocks such as reference rams or shared rams. It will never be possible to compare every sheep across-the-board and, for that reason, results are published on a breed-by-breed basis, not simply listing animals across breeds, except where trials such as RamCompare enable this to be done.

While it is a challenge maintaining genetic linkage between flocks, by working together, breeders can enable robust comparisons to be made within their breed. Through collaboration in projects such as RamCompare, comparisons can sometimes be made between rams of different breeds.

ADVICE TO BREEDERS

- Work together to share rams and create genetic linkage between recorded flocks
- Use Signet-recorded rams of known genetic merit
- Seek advice from Signet on your flock's genetic linkage to other flocks
- Where multiple flocks are run together on the same holding:
  - Ensure Signet links the flocks to create a single contemporary group
  - Record management groups in a consistent manner across the linked flocks
- Consider involvement in RamCompare or using breeding lines tested in RamCompare

A new online tool is being developed to assess and report the degree of linkage that exists between flocks.

STRENGTH OF COMPARISON

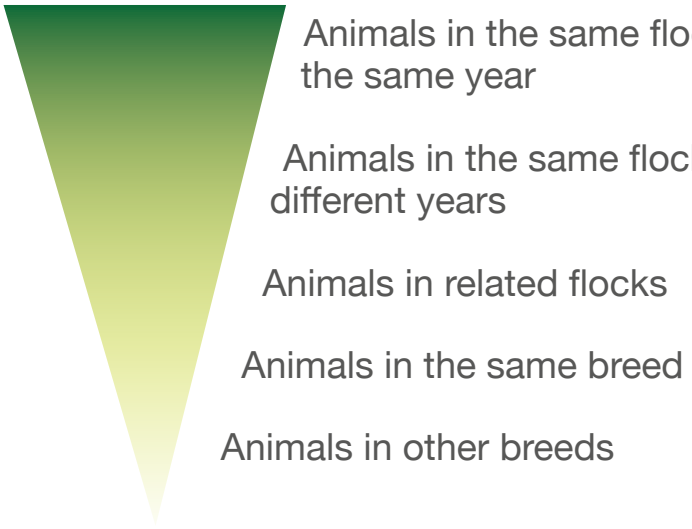

Figure 20. Suffolk stock ram working in the Sampfordel Suffolk flock

BREEDING INDEXES

In the past, many breeds had breed-specific Terminal Sire Indexes. However, a review of these indexes in 2017 showed they largely achieved the same objective and led to similar rates of genetic gain, regardless of whether the bulk of the emphasis in the index was placed upon the traits measured on farm or at the CT unit.

In common with countries such as Australia, New Zealand and Ireland, the starting point for this analysis will be the production of two standardised, commercially focused indexes, the Terminal Sire Index and the Maternal Index.

TERMINAL SIRE INDEX

This index will continue to balance the requirement to produce fast-growing lambs with the need for a high yield of meat in their carcase. Steps will be taken to further reduce the current low emphasis on leanness, to encourage the optimisation of finish in slaughter lambs.

New traits influencing spine length and intramuscular fat will not initially be incorporated into the index.

MATERNAL INDEX

For most breeds, this is a new development, with only the Dorset and Suffolk breeds having had a Maternal Index in the past.

The new index will be similar to the current approach, but the emphasis on growth and carcase traits will essentially change where traits have become weight-adjusted.

No emphasis will be placed on selecting for leaner breeding lines, but a small negative weighting is being placed on the breeding values for shearling weight/ewe mature size, with the aim of enhancing overall ewe efficiency.

Figure 21. Suffolk ram Bentley Olympic Gold bred by the Harding family

THE ROLE OF RAMCOMPARE

RamCompare is the UK's first commercial progeny test. It was launched in May 2015, with funding agreed to collect data from commercial farms for five years. Eight commercial farms are currently involved in data collection.

Over five years, more than 50,000 slaughter lambs will have weights and carcase information recorded to identify which rams have the most profitable genes for traits influencing carcase value and speed to slaughter.

The project will also assess:

- The feasibility of including data collected from commercial farms and abattoirs in genetic evaluations
- How the progeny of rams assessed in pedigree flocks perform under commercial, forage-based management
- How EBVs for new traits such as CT spine length might influence economically relevant traits, such as carcase weight and conformation

From the point of view of the National Terminal Sire Evaluation, RamCompare provides a valuable comparison between rams of different breeds, and has the potential to strengthen genetic linkage between Signet-recorded flocks.

Nominations are open to Signet clients each year to put forward both semen and rams for use by natural service.

Breeders should give serious consideration to getting involved as an effective way to enhance their flock analysis and increase the profile of their breeding stock.

RamCOMPARE

FUNDERS

AHDB, Hybu Cig Cymru, QMS, AgriSearch, Sainsbury's

COLLABORATORS

dunbia, Randall Parker Foods, ebvc, SRUC

SUPPORTERS

Allflex, Shearwell Data, Elanco, FARMPLAN, Farmit 3000

RamCompare results are published at ramcompare.com with updates via Twitter @RamCompare.

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