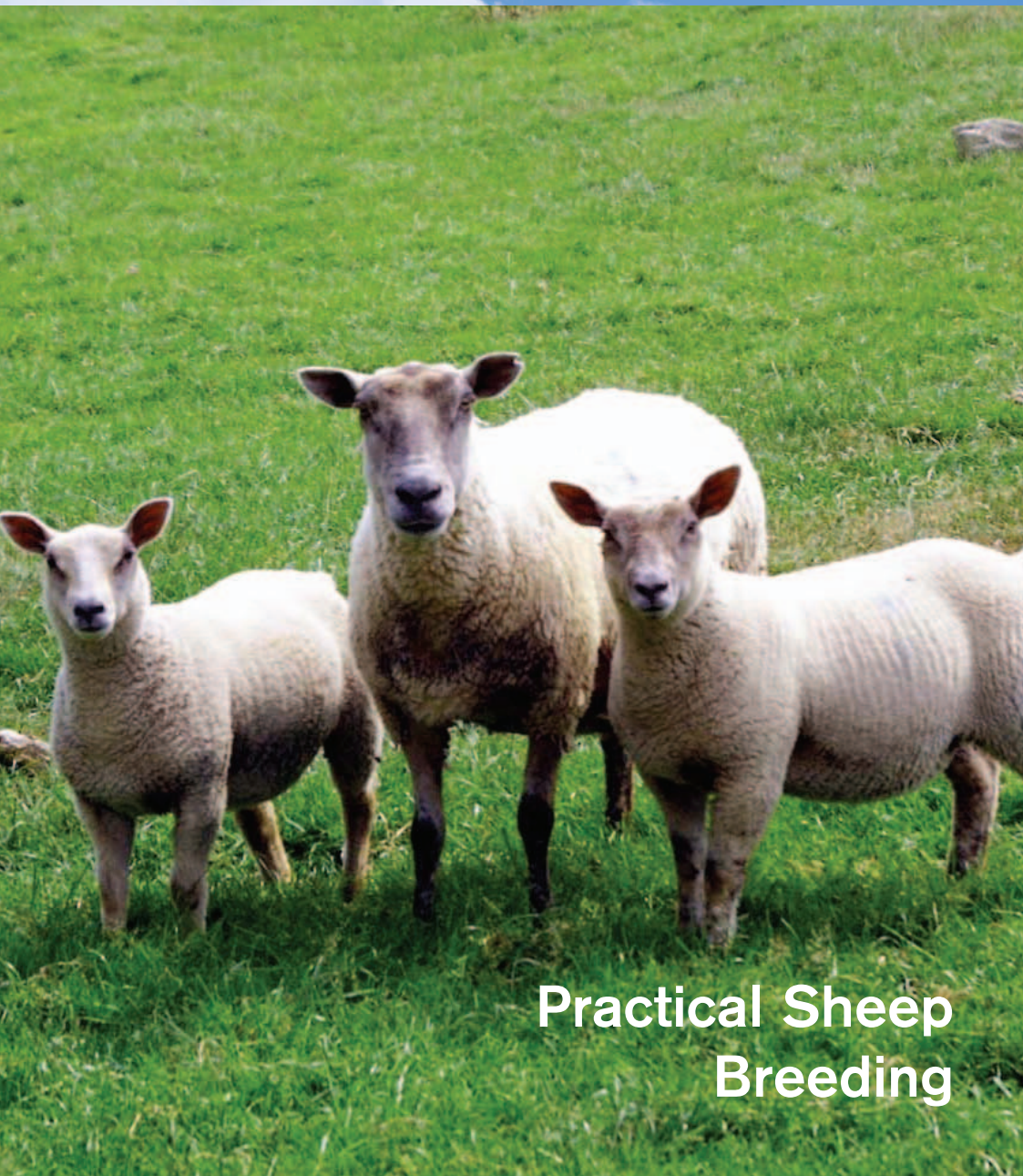
HYBU CIG CYMRU
MEAT PROMOTION WALES



Practical Sheep Breeding

Introduction

Hybu Cig Cymru/Meat Promotion Wales (HCC) was established in April 2003 and is the strategic body for the promotion and development of the Welsh red meat industry. Its mission is to develop profitable and sustainable markets for the benefit of all stakeholders in the supply chain.

It brought together the red meat activities of three organisations, namely the Meat and Livestock Commission in Wales (MLC Cymru), Welsh Development Agency and Welsh Lamb and Beef Promotions Ltd. Each organisation was responsible for different aspects of red meat activity, which have now been integrated into HCC's work.

HCC is now the sole body for the promotion and development of red meat in Wales.

This booklet forms part of a series of publications produced by HCC's Industry Development Team.

Practical Sheep Breeding

Since man first domesticated sheep, he has used selective breeding to improve economically important traits, such as growth rate and wool quality. In the present commercial environment the need for selective breeding decisions is as important as ever. Sheep producers can only maintain their businesses by producing lambs that meet market specifications, in terms of carcase weight, fat class and conformation. Allied to this is this need to monitor production costs to ensure lambs are produced efficiently, and ensure the flock will generate a positive financial return.

Short-term changes are relatively easy to implement. For example, farmers can enhance flock health and lamb survival and ensure the right lambs are selected for slaughter. However, a lamb's potential to produce a quality carcase is ultimately limited by its breeding potential and this is fixed at the point of conception. Breeders need to make long-term plans to invest in the right breeding stock for their enterprise.

This leaflet highlights why breeding improvement is so important to the industry and how commercial sheep producers can use this information to enhance flock profitability.

Contents

Importance of Breeding Potential

Breeding and the Producer

The factors that influence livestock performance can be divided into those that are due to an animal's breeding potential, as determined by it's genes, and those due to the environment in which it is reared.

It is important to get both of these aspects of production right, but whilst the management of a sheep can be changed throughout it's productive lifetime, breeding potential can only be influenced before it is conceived. This makes the selection of breeding stock extremely important.

The only influence that a ram has over it's offspring is through it's breeding, so it is vitally important to assess this element of a ram's performance separately from the combined visual impact created by feeding, management and breeding. It is not possible to identify a good ram by "eye alone"; ram buyers need **performance records to assess breeding potential.**

The first computerised breeding calculations were completed by MLC in 1971. New techniques have been developed to assess carcase attributes, using ultrasound scanning and computed tomography, and new indexes have been created to complement industry breeding objectives. The commercial ram buyer can now purchase the most profitable breeding stock for their enterprise with confidence.

Ram buyers can't distinguish between a well fed and a well bred ram, without performance records

Breeding and the Industry

At an industry level, breeding improvement has a special importance, because of the advantages it has compared to other management strategies. Breeding improvement is permanent, cumulative, sustainable and cost effective.

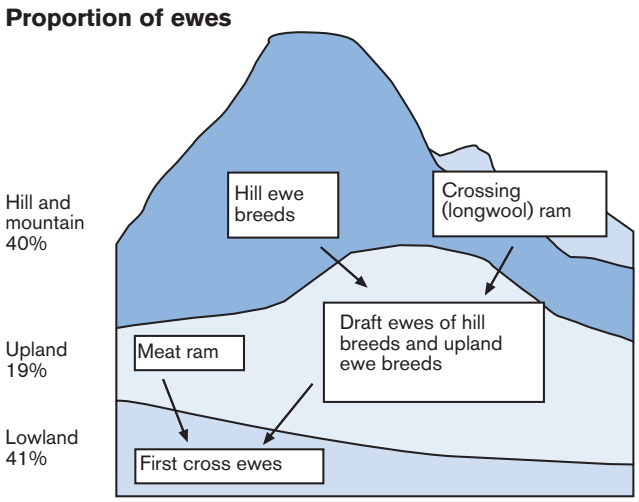
- **Permanent:** the genetic potential of an animal is independent of environmental and management changes and does not change throughout an animals life.
- **Cumulative:** improvements made to one generation are added to those made in previous generations.
- **Sustainable:** improvements can continue to be made as long as there is genetic variation
- **Cost effective:** the financial benefits to the British sheep industry due to breeding improvement of terminal sire breeds since the late 1980s is estimated to be worth £4.8 million (Simm, Amer & Pryce, 1997).

Breeding in a Stratified Sheep Industry

Britain is unique in having stratification at the heart of its sheep industry. Stratification is characterised by a three-tier breeding structure related to altitude and grazing.

The first tier is in the hill areas where ewes of the **hill breeds**, e.g. Hardy Speckelfaced and Welsh Mountain are maintained in self-contained flocks under relatively harsh conditions. Surplus breeding stock from these flocks in the form of cast ewes are transferred into the uplands, the second tier of the industry, where they are crossed with specialised **longwool ram breeds**, such as the Bluefaced Leicester and Border Leicester.

The first-cross ewe lambs are transferred to the lowland areas, the third tier, where they are generally crossed with rams of the **terminal sire breeds**, e.g. Suffolk, Texel and Charollais, to produce slaughter lambs. Although this is the general trend there are many regional variations.

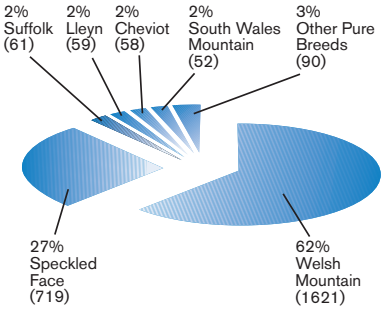


Stratification means that a wide range of farm environments in the UK can be exploited by using breeds and crosses that are suited to the different areas and production systems. Specialised sire and dam breeds have developed as a result.

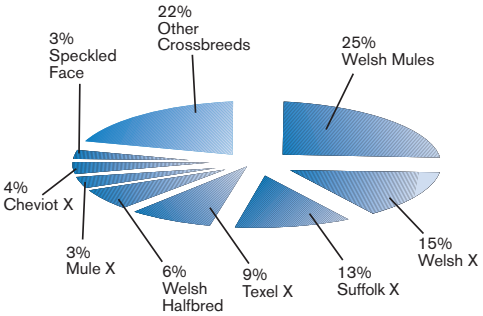
The structure also makes the most of breed complementarily and heterosis (hybrid vigour). The crossbreeding of hill ewes with longwool rams produces more prolific crossbred ewes with higher bodyweights than their pure-bred mothers and maximises heterosis for maternal traits and survivability. Mating terminal sire breeds to crossbred ewes enables farmers to produce slaughter lamb carcases that meet the quality requirements of the market.

Results from the Welsh breed survey undertaken in 2001 showed that 63% of the Welsh flock was pure bred with the remaining 37 crossbred. The 2 pye charts below demonstrate the distribution of breeds within pure breed and crossbreed flock in Wales.

Pure breeds within the Welsh flock

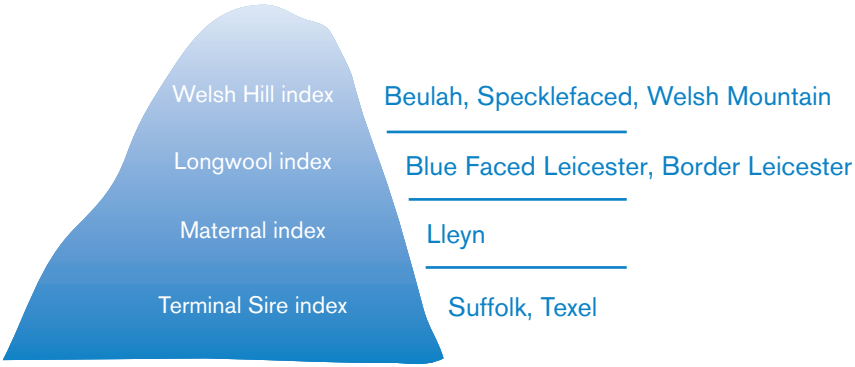


Cross Bred Ewes in Wales



Breeding Index

Each tier of the industry has a requirement for purebred breeding stock. Breeding improvement strategies have evolved to meet these demands, with **specialised breeding indexes** being produced for each major breed.



Breeding Improvement Strategies

Performance recording schemes assist breeders to identify animals with superior breeding potential and encourage their wider use within the industry.

These schemes are required because the performance of livestock is dependent on both their breeding and a host of environmental factors such as feeding and management. Recording schemes attempt to separate the effects of breeding and the environment on animal performance to enable the identification of those animals whose breeding is truly superior.

Breed improvement is a slow process, but real progress can be made if detailed performance records are maintained and breeding animals are selected on the basis of objective measurements.

Sheep Recording

Can be separated into two main activities, data collection and data analysis.

1. Data collection

Data collection involves the breeder recording and submitting information about his flock including:-

- **Pre-mating.** New flocks submit details of their breeding rams and ewes. Weights for homebred female shearlings can be submitted.
- **Lambing.** Lambing lists and diaries are sent to breeders. For each lamb, the breeder records it's identity, sex, date of birth, dam identity, dam age, sire identity and litter type (single, twin etc). Management practices such as embryo transfer, fostering and artificial rearing are also recorded. Once the bulk of lambing has been completed these are sent for computer entry.
- **8 weeks post lambing.** improvements can continue to be made as long as there is genetic variation
- **21 weeks post lambing.** A list of all the lambs held on file is sent to the scanning operator who will then make an appointment with the breeder to weigh and scan lambs using ultrasound.

At each stage a series of validation checks is applied to retain the integrity of the database, ensuring the analyses undertaken are of the highest quality.

The standard measurements of performance are shown in Table 1. Recent research has generated a range of new traits, which are primarily being used amongst terminal sire breeders. These are presented in Table 2.

Table 1. Standard Performance Traits

Raw Data	Trait	
Litter Size Born	Prolificacy	This trait is defined as the total number of lambs born alive and dead when pregnancy reaches full term. Ewes that are barren or abort are considered to have a litter size of 0.
Litter Size Reared	Prolificacy Maternal ability of ewe	If lambs are weighed at 8 weeks of age or at scanning they are deemed to have been successfully reared and the ewe's performance record will be credited accordingly.
Eight Week Weight (kg)	Growth rate to 8 weeks of age Maternal ability of ewe	Weight at 8 weeks of age. To achieve an adjusted 8-week weight lambs must be weighed between 42 and 84 days of age.
Scan Weight (kg)	Growth rate to 21 weeks of age	Weight at scanning time, when lambs are 21 weeks of age.
Muscle Depth (mm)	Carcase muscling	Measured at 21 weeks of age by a technician. One ultrasound measurement taken across the third lumbar vertebra.
Fat Depth (mm)	Leanness	Measured at 21 weeks of age by a technician. Three ultrasound measurements taken across the third lumbar vertebra.
Mature size (kg)	Ewe efficiency	Ewe liveweight at first mating.

Table 2. New Performance Traits

Raw Data	Trait	
Carcase Lean Weight (kg)	Muscle yield	Quantity of muscle tissue in the carcase assessed using Computed Tomography (CT) image analysis of breeding stock at 21 weeks of age.
Carcase Fat Weight (kg)	Leanness	Quantity of fat in the carcase assessed using Computed Tomography (CT) image analysis of breeding stock at 21 weeks of age.
Muscularity (mm)	Carcase shape	Thickness of the muscle tissue in the gigot assessed using Computed Tomography (CT) standardised to a fixed femur length.
Faecal Egg Count (FEC)	Worm resistance	Faecal samples are taken from lambs at 21 weeks of age and submitted for laboratory analysis to measure the worm egg count in the sample.

2. Data Analysis

A statistical procedure called BLUP, Best Linear Unbiased Predictor is used to estimate the breeding potential of every animal in the flock is used.

Each animal receives an analysis based on it's own performance, as well as that of its relatives and ancestors. The analysis takes into account the relationships between the animals, known relationships between recorded traits and the degree to which each trait is inherited by the next generation (heritability). The results produced by the analysis are referred to as **Estimated Breeding Values.**

Estimated Breeding Values (EBVs)

EBVs predict the superiority (or inferiority) of the genes that an animal possesses for each measured trait. They are expressed in the same units as the recorded traits (e.g. kg for liveweight) and expressed relative to a common baseline for all animals in the same evaluation.

EBVs predict the breeding potential of the recorded animal. On average each animal only passes half of its genes to the next generation. Consequently their EBVs must be halved in order to estimate how much of its genetic superiority (or inferiority) will be passed on.

EBVs can be calculated on an across -flock basis, enabling animals in the same breed to be directly compared, provided that strong genetic linkage exists between flocks. **EBVs can not be compared across different breeds.**

8-Week weight EBV

This is a measure of the animal's genetic potential for growth from birth to weaning at 8 weeks.

A ram with an EBV of +3 for 8-week weight is expected to produce lambs which, on average, are 1.5 kg heavier at weaning compared to lambs sired by a ram with an EBV of 0.

Scan weight EBV

This is a measure of the animal's genetic potential for growth from birth to 21 weeks of age (age at scanning). Selection for high scan weights results in animals that will have heavier carcases at a constant fat class or leaner carcases at a constant age.

A ram with an EBV of +4 for scan weight is expected to produce, on average, lambs 2 kg heavier at 21 weeks than lambs sired by a ram with an EBV for this trait of 0.

Muscle depth EBV

This is a assessment of loin muscle depth and therefore likely lean meat yield.

A ram with an EBV of +1 for muscle depth is expected to produce, on average, lambs with 0.5 mm greater eye muscle depth at 21 weeks compared to lambs sired by a ram with an EBV of 0.

Fat depth EBV
Negative values indicate animals with lower fat levels, which will produce leaner carcases or which can be taken to heavier weights without becoming over-fat.

A ram with an EBV of -1.0 for fat depth is expected to produce, on average, lambs at 21 weeks with a subcutaneous fat thickness 0.5 mm less than lambs sired by a ram with an EBV of 0.

Mature size EBV
Positive figures identify breeding lines that will be bigger at maturity. In certain hill breeds, even though it is advantageous to enhance lamb growth rates, it may be desirable to restrict increases in the mature size of the ewe.

A ram with a litter size EBV of +0.3 is expected to produce ewe lambs that will have, on average, 0.15 more lambs than ewes from a ram with an EBV of 0.

Maternal Traits
Many traits are expressed by both sexes (e.g. growth rate and muscling), but maternal traits (e.g. litter size and maternal ability) are only expressed by females. A ram's maternal EBVs, when halved, provide an indication as to how his female offspring will perform when they become mothers.

Litter size born EBV

A ram with a litter size EBV of +0.3 is expected to produce ewe lambs that will have, on average, 0.15 more lambs than ewes from a ram with an EBV of 0.

Maternal ability EBV
This is the maternal component of the 8-week weight measurement. It gives an indication of how well a ram's ewe lambs will perform as mothers. A ewe's EBV for maternal ability estimates how much of its lambs' performance up to eight weeks of age is due to maternal characteristics such as milkiness and maternal care of the lamb.

A ram with a maternal ability EBV of +0.5 is expected to produce ewe lambs that will have above average maternal characteristics leading to their lambs being 0.25 kg heavier at 8 weeks than lambs from ewes sired by a ram with an EBV of 0.

Accuracy of EBVs

Accuracy is a measure of how near the EBV is to the 'real' breeding value of the animal. There are several factors that affect the accuracy of an EBV:

- the amount of information on the trait from the animal itself
- the amount of information on the trait from relatives of the animal and the class of relative (e.g. parent, progeny, half-sib)
- the heritability of the trait
- the amount of information from the animal and its relatives on traits correlated with the trait of interest and the strength of the correlations
- the number of animals being measured in the same contemporary group

An important feature of BLUP EBVs is that they are scaled to account for the amount of performance information on which they are based. EBVs based on very little information get adjusted towards the average EBV. This adjustment applies to both high and low EBVs. In other words, it is difficult to get either a very high or very low EBV on the basis of little information. The more information available on an animal and its relatives, the less the EBVs are adjusted and the more accurate they are.

This feature of BLUP is a valuable way of accounting for the risk involved in making breeding decisions. It helps to avoid selecting animals which, on the basis of flimsy evidence, appear to have high genetic merit but which might turn out later to be poorer than expected. The chance of an individual animal's EBVs going down over time is exactly the same as the chance of them going up.

Breeding Indexes

EBVs are published for every measured trait, which allows breeders that are making selection decisions to decide how much emphasis they wish to place on each trait.

EBVs can also be combined into a multi-trait selection index, or 'breeding index', created to meet a specific breeding objective, or set of objectives, and selection can be based on this. It is widely agreed that this is the most efficient way to improve several traits at once. Economic weightings relevant to current market conditions can be used to ensure each trait is given the appropriate amount of emphasis in the index.

There are five breeding indexes which are widely used in the UK:

- Terminal Sire Index
- Welsh Hill Index
- Maternal Index
- Hill Index
- Longwool Index

Terminal Sire Index

The Terminal Sire Index has been successfully used in the UK for over 15 years. Its use has greatly enhanced the growth potential and carcase attributes of all the main terminal sire breeds, producing a population of recorded rams whose progeny are more valuable to the commercial producer.

Breeding Objective	Influential EBVs	Breeds
To increase the yield of lean meat in the carcase whilst minimising any associated rise in carcase fatness.	Scan weight Muscle depth Fat depth Carcase lean weight (CT scanning breeds) Carcase fat weight (CT scanning breeds)	Bleu du Maineand dead Charollais Hampshire Down Il de France Meatlinc Poll Dorset Suffolk Texel Vendeen

Recent Developments

In 2004 the Terminal Sire index was modified for certain breeds, to more closely meet their individual breeding objectives. These enhancements included:

- A change to the weighting of fat depth, placing an additional penalty on the index of rams with low fat depth EBVs whose progeny were perceived to be more difficult to finish under extensive conditions.
- A positive weighting was applied to muscularity, for those breeds involved in CT scanning, in order to enhance carcase shape.
- The provision of an economic index. This enables the breeding potential of recorded stock to be expressed in financial terms.

Welsh Index

The Welsh Index is designed to assist in the selection of hill sheep in order to improve maternal ability, lamb growth rate and carcass value. It was originally developed for Welsh hill breeds.

Using this index as a guide to the selection of stock rams and ewe replacements will produce a flock of ewes that get their lambs off to a good start and that grow on to produce a heavier carcass, with a high proportion of lean meat.

The index takes into account two breeding goals:

1. Maternal ability which is assessed through the performance of a ewe's lambs at 8 weeks of age. The Maternal EBV is a measure of the ewe's genetic merit for milkiness and general mothering ability.

2. The lamb's own potential for growth and carcass composition which is assessed through scanning measurements of fat and muscle depth, together with weight at scanning. This objective aims to identify animals that will produce heavy carcases, with a high proportion of lean meat.

Breeding Objective	Influential EBVs	Breeds
To enhance maternal ability, growth rate and carcase conformation.	Maternal ability Muscle depth Fat depth Scan weight	Welsh Mountain Beulah Lleyn

Welsh Mountain Rams

Maternal Index

The maternal index was created to enhance the productivity of the lowland ewe, bearing in mind that two of the main factors influencing flock profitability are the number and weight of lambs, reared per ewe, to slaughter.

Ram buyers looking to buy a ram to breed female replacements should use this index to identify a stock ram that will produce productive female progeny. The weightings placed upon the individual EBVs will vary depending on the breeding objectives of the breed.

Breeding Objective	Influential EBVs	Breeds
To increase the productivity of maternal breeds of lowland ewe	Eight week weight Maternal ability Mature size Litter size	Lleyn Poll Dorset

Lleyn

Longwool Index

The Longwool Index was created to assist breeders with the selection of rams that are to be used as crossing sires, when mated to hill ewes.

Selection using this index will improve the financial productivity of the longwool breeds. In purebred flocks, carcase conformation will be enhanced and growth rate will increase, but the rate of increase has been controlled so that the mature size of crossbred ewes does not become excessive.

Commercial producers using this index to select stock rams to breed female replacements, will produce a flock of crossbred ewes whose lambs will have better quality carcases, with a high yield of lean meat.

Breeding Objective	Influential EBVs	Breeds
To enhance carcase characteristics, without detriment to the maternal performance of the crossbred ewe	Muscle depth Scan weight Maternal ability	Blue Faced Leicester

Blue Faced Leicester

Hill Index

The most important attributes of a hill ewe are those that make her a 'good mother'. She must be able to survive, conceive, give birth to and raise her lambs in environmental conditions that are often harsh. However, increasing pressure on all sectors of the sheep industry to improve carcase quality means that hill sheep must also produce lambs that grow well and meet market specifications.

This presents a challenge to hill sheep breeders, who need to select breeding stock to improve both maternal and carcase characteristics.

The most effective way to simultaneously improve this diverse range of traits is through index selection. The hill index takes into account, this wide range of breeding goals in order to enhance the overall productivity of the hill ewe.

Breeding Objective	Influential EBVs	Breeds
To enhance the productivity of the hill ewe	Eight week weight Scan weight Mature size Litter size Maternal ability	Cheviot Herdwick Scottish Blackface Swaledale Rough Fell

Cheviot

Making Faster Progress

It is difficult to compare the breeding potential of two rams reared in different flocks, because differences in flock management and environmental conditions can mask differences in breeding potential.

Many pedigree flocks in Britain are small (with the exception of hill breeds where recording the entire flock is difficult) so unless animals in different flocks can be accurately compared the level of choice when making selection decisions is low, limiting the rate of genetic progress.

Sire Reference Schemes (SRSs)

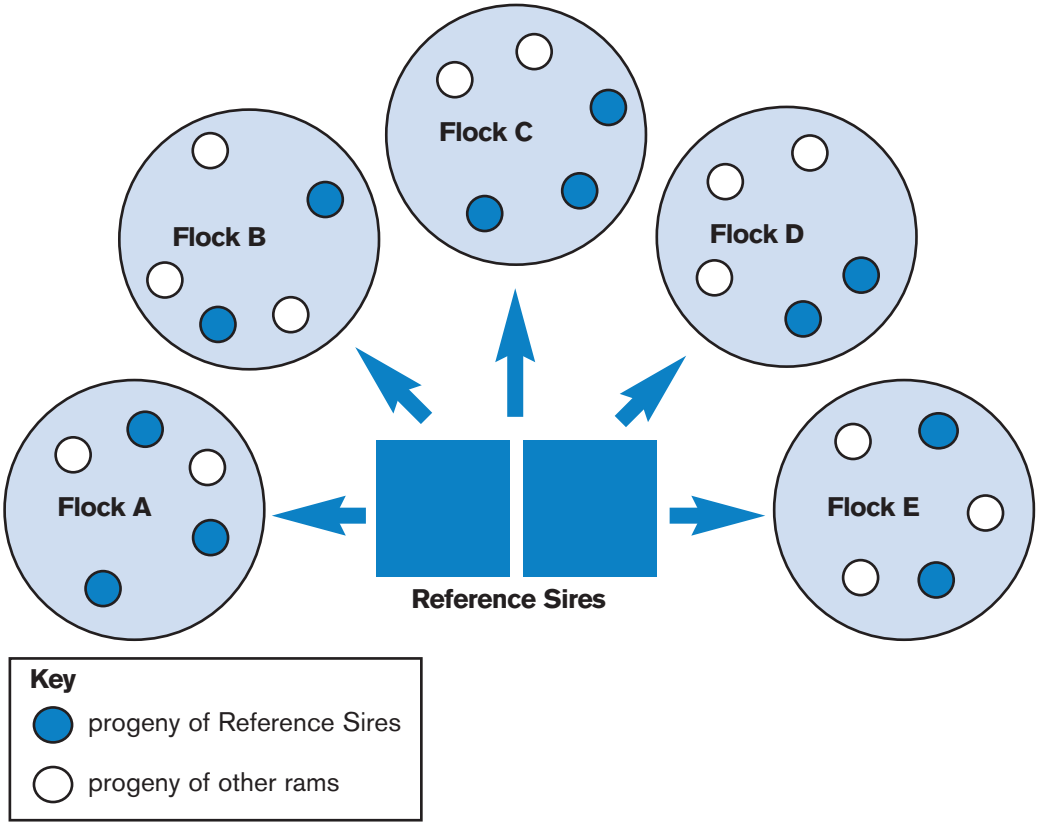
Sire Reference Schemes were established to overcome this problem. These schemes encourage recording breeders to work together to share popular breeding lines in order to create genetic linkage between recording flocks.

The progeny of these 'reference sires' create a benchmark against which all other lambs can be compared, enabling them to be ranked as if they were in a single flock. By linking the flocks in this way the size of the population from which replacements could be selected is greatly enlarged. This co-operative approach has enabled recording breeders to make much faster rates of breeding improvement, choosing the very best sires from thousands of potential candidates.

Signet now analyses over 25 different Sire Reference Schemes every year. The technical developments, that have helped to make Sire Reference Schemes successful, are:

- tools to facilitate objective performance recording, e.g. ultrasonic scanners and computed tomography
- improved success rates of laparoscopic AI using frozen semen
- powerful computers and sophisticated software to analyse the results

Figure 2: Schematic Diagram of a Sire Referencing Scheme



Whole Breed Analysis

To increase the impact of recording within the UK's main terminal sire breeds a new data analysis service was developed in 2004. 'Whole Breed Analyses' incorporate data from both Sire Reference Schemes and Within Flock recording breeders into a single analysis for the breed, making it easier for potential ram buyers to select the right recorded rams.

Breeders will still be encouraged to generate genetic linkage to other recording flocks to ensure that accurate across flock comparisons can be made, but the new service also provides greater flexibility, enabling smaller flocks to actively participate in performance recording.

Financial Impact of Breeding

Sheep producers need to decide their flock breeding objectives in order to work out which EBVs they require when selecting breeding stock.

Each of the main economic drivers that determine the financial performance of a sheep enterprise is influenced by the breeding potential of the flock. The key to successful ram selection is to identify the breeding traits that will enhance flock profitability the most.

Breeding influence		Economic driver
Growth Rate (Scan weight EBV)	→	Variable and Fixed Costs of Production Liveweight / Carcase weight Seasonal price
Muscling and Leanness (Muscle depth and Fat depth EBVs)	→	Carcase grade
Maternal Performance (Litter size and Maternal ability EBVs)	→	Number of lambs born and reared

Trials show that producers can improve the financial performance of their flocks by at least £2 - £2.50 per lamb through the selection of breeding stock with high indexes.

A stock ram, working over four years, will probably sire 240 lambs during his lifetime. On this basis, choosing the right ram for your system could be worth an extra £480 - £600 per ram – so it is **well worth investing in the right recorded ram**.

Further information

Please contact HCC's Industry Development Team
Tel: 01970 625050 or email: enquiries@hccmpw.org.uk

For further information on this brochure or the work of HCC please visit www.hccmpw.org.uk