Nuffield Farming Scholarships Trust

The Opportunity for Composite Flocks within the UK Sheep Industry

Central Region Farmers Trust Award

Samuel E. Boon

24 Abbey Road
Bradwell Village
Milton Keynes
Buckinghamshire
MK13 9AL

The Opportunity for Composite Flocks within the UK Sheep Industry

Contents

The views expressed in this report are entirely my own and do not necessarily represent the views of the Nuffield Farming Scholarships Trust, or my sponsor, or of my employers, or any other sponsoring body.

Background

While studying at Reading University and the University of Wales – Bangor I was always inspired by those topics that related to breeding improvement. Nearly every aspect of livestock production can be enhanced through the use of improved genetics if those animals possessing the right combination of genes can be identified.

In 1967 the Meat and Livestock Commission (MLC) established a service to performance record sheep and beef cattle within the UK to identify animals possessing genes of economic importance. The structure and ownership of this service has changed over time and it is now run as MLC's Signet Breeding Services (Signet). I have worked for Signet for eight years, the last four years as Signet Manager.

I can see the impact that breeding improvement can have upon a livestock industry through within breed selection, but I was interested to learn what potential there was for the selection of traits across breeds and the creation of crossbred "composite breeding lines".

Over time I have observed that the successful establishment of a breed or breeding line, whilst obviously influenced by the economic value of the genetics it possesses, is more closely related to the strength of those breeding businesses that are marketing it. For this reason my study has considered the features that are required to run a successful breeding business, because I believe it will be the quality of the breeding business not just the quality of their genetics that will determine whether composite breeding businesses become successfully established in the UK.

Brief outline of the tour

My study tour covered Australia, New Zealand, America and Canada. I visited a number of sheep producers that were selling breeding stock (both purebred and composite lines). Contacts were made with the organisations responsible for delivering performance recording services to each of these countries (Lambplan, SIL, NSIP and Genovis) and meetings were held with several leading geneticists. Visits were made to commercial producers to see what composites deliver in a commercial, subsidy free environment and to gain an insight into future breeding goals.

Acknowledgements

In completing this scholarship I would like to thank:

- Nuffield Farming Scholarships Trust
- My sponsors the Central Region Farmers Trust
- Breeders and Academics that gave up their time to meet me (Appendix 1)
- My employer, the Meat and Livestock Commission
- Signet and MLC colleagues for their invaluable support

Samuel Boon, December 2006 (Email: samuel_boon@mlc.org.uk)

Section 1. Introduction "An Opportunity for Change"

The British sheep industry faces a period of massive change and opportunity following substantial changes to the financial support mechanism that has underpinned sheep production in the past. Producers will need to enhance the productivity of their flocks, whilst remaining mindful of their costs of production, if they are to remain profitable.

Every aspect of sheep production will fall under the spotlight in this new era and technical improvement is required in a number of areas. It is clear that the use of superior genetics is one area in which gains can be made, but what is less clear is how pedigree sheep producers will evolve to meet the challenges now facing their commercial clients.

This report focuses on ways that pedigree producers can use composite breeding strategies in the production of breeding stock to enhance the productivity of commercial sheep production.

- The study takes a look at some of the breeding programmes that are being used overseas to create composite breeding lines and identifies the advantages and disadvantages of using a composite approach.
- Technical innovation has driven the development of composite production overseas and this paper briefly touches upon a number of areas of technical development that could influence the establishment of composite businesses in the UK.
- The potential to generate genetic change within an industry is influenced by the profitability of those producers marketing breeding stock. This study reviews the features that underpin the financial success of a breeding business.
- British producers interested in producing composite breeding lines have two options: to import ready-made composites or to develop them using existing breeds. Consideration is given to these two approaches.

This report shows that far from being a threat that will jeopardise the traditional British pedigree industry, composite breeding strategies provide healthy competition that will stimulate the development of more efficient and responsive sheep breeding businesses, both purebred and composite.

Figure 1. Terminal Sire Composite Breeding Line in New Zealand

Section 2. Composite sheep production overseas

2.1 What is composite breeding?

Composite breeding is the creation of a new (synthetic) breed formed by crossing two or more breeds and then selecting crossbred animals within that population. Crossing in this manner is not the indiscriminate mixing of breeds, but rather the systematic use of different breed resources to produce crossbred animals for a specific breeding objective. The development of composite breeding lines is well documented within most livestock species.

The principle is far from new. Many British breeds were established through crossbreeding (the Suffolk is a Norfolk Horn / Southdown cross) and many have been “enhanced” over time with the addition of new blood. New breeding lines are continually being developed. British examples developed over the last 30 years include the Colbred, Meatlinc, British Milksheep, Cadzow Improver, ABRO Damline, Hartline and Cambridge.

Despite these developments the use of composite breeding lines in the UK has not become widespread. Few of the breeds listed above, with the exception of the Meatlinc, have had widespread commercial success.

Reasons for this include:

- Poor marketing and a lack of commercial demand. Breeders producing composite rams didn’t have the support of a breed society or other credible marketing organisation.
- Buyers were selecting animals of unknown breeding potential. Few of these breeds could be purchased on the basis of their EBVs (Meatlincs being an exception). Buyers had to buy rams based on their appearance, which in many cases would not have been particularly visually appealing.
- Crossbreeding programmes are technically complicated; as they require high levels of management and large populations of animals. The average British breeder simply couldn’t achieve this level of complexity without scientific support.
- Too much emphasis was placed upon the importance of uniformity. Within closed populations issues relating to inbreeding quickly stifled genetic progress and reduced vigour.
- Stratification within the industry, with purebred hill breeds being used to create first cross female replacements for use in commercial lowland flocks.

This doesn’t mean a British composite would not be readily accepted today. Producers are now more technically aware, responsive to change, appreciate the value of recorded genetics and understand the principles of composite production. However, lessons from the past must be learnt, particularly with regard to the marketing of composite breeding stock.

2.2 Composite case studies

During my Nuffield Tour a number of composite producers were visited. The following flocks have been chosen to provide short case studies.

V. John Keiller - Cashmore Park, Australia
VI. Tisdale's Superior Polypays - Nebraska, North America
VII. Ian and Deb Clark, Rideau Breeding Lines - Alberta, Canada
VIII. Katahdin Hair Sheep - America and Canada

Case Study I. John Keiller, Cashmore Park, Australia

John Keiller at Cashmore Park has developed two composite breeding lines. A composite terminal sire (containing Texel, White Suffolk and Poll Dorset) and a composite maternal line (including Finn, Friesland, Coopworth, Border Leicester and some terminal sire genetics).

Since the flocks were created in 1992 the best genetics, regardless of breed have been located and tested to see what they have to offer. The flock aims to maximise genetic progress in economic traits using performance recording, whilst retaining easy-care characteristics.

The Cashmore Park breeding flocks are run under strict commercial conditions in conjunction with a large commercial prime lamb flock. This approach generates more accurate EBVs, removes animals lacking commercial constitution and allows progeny testing on a large scale.

Opportunities

John's genetic knowledge is outstanding. Considering the work that has gone into importing elite genetics from across Australia and New Zealand these flocks will contain truly unique genes. Cashmore Park is by far the most extreme open composite breeding programme that I saw on my travels. The challenge for John is capitalising on these genetics to improve his financial returns from ram sales.

Marketing

The business still faces the challenge of marketing large numbers of composite rams on the basis of their EBVs, with both on farm sales and auctions being used to sell stock. John recognises the importance of marketing, he retains a high profile within the farming press and communicates regularly with his clients via a professionally produced newsletter.

Plans for the Future

The flock is focussed on innovation and Cashmore Park is involved in a number of R&D projects in conjunction with MLA and Lambplan. These include looking at the genetics of meat eating quality and the use of molecular markers for carcase traits such as the Carwell gene. In recent years a shedding, easier care line has been developed.

Case Study II. Tisdale Polypay – Dwight and Sharon Tisdale, America

Breed Development

The Polypay was developed in 1968 as a maternal composite with high reproductive capacity and acceptable growth rate and carcass quality. Many breeders now regard the breed as dual purpose.

Four breeds were used to establish the breed, the Rambouillet and Targhee for hardiness, large body size, herding instinct and fleece characteristics; the Dorset for carcass quality, milking ability and long breeding season and the Finnsheep for early puberty, fertility and high lambing rate.

The reproductive performance of Polypay ewes selected for high once-a-year lambing rate under typical range management conditions is competitive with that of Finn F1 crossbreds, but they possess superior carcases.

The phenotypic variation amongst mature sheep is noticeable, although this should not be an issue for commercial buyers. Despite this variation some breeders are showing their Polypays, which may inevitably prove detrimental to the development of the breed. Unfortunately US sheep breeding programmes don't provide EBVs for muscle and fat depth, which will slow genetic gain in carcase traits.

Marketing

Marketing is taken very seriously at "Tisdale Superior Polypays". Dwight and Sharon have sold their home and dispersed their flock to set up nucleus flocks to supply breeding animals. Large distances are covered in their motor home and their income is now based on trading, rather than rearing Polypay sheep. Demand for ewes far exceeds that for rams.

Plans for the Future

The Polypay breed has become widely accepted by commercial sheep producers, particularly those with self replacing flocks. The commercial focus with which the breed was developed means it is a serious rival to both terminal sire and maternal breeds. Recent interest has been focussed on increasing the ability of the Polypay to lamb out of season, so they can be lambed every 8 months to produce a consistent supply of American lamb to the retailer**.**

Case Study III. Medicine Ridge Genetics – Ian and Deb Clark, Alberta, Canada

Breed Development

The breeding enterprise at Medicine Ridge was established in 1988, when the government of Canada released three new Composite sheep breeds to the industry. Ian and Deb Clark were able to obtain two of them, the Canadian Rideau and Rideau Arcott.

Rideau Arcott – Maternal Line

The Rideau Arcott is a maternal line created over 30 years at the federal government research station using mainly Finnish Landrace, Suffolk and East Friesian genetics. The purpose of the Rideau Arcott programme was to produce a dam-line breed for crossbreeding that would offer ewes with high fertility, good milking characteristics and good body conformation and growth rate.

At Medicine Ridge selection pressure is still applied to improve prolificacy. Ewes that only bear twins or are incapable of rearing triplets are culled from the breeding programme. Most of the ram lambs retained for breeding are well grown quads.

Rideau Arcott – The Commercial Application

The prolificacy of Rideau Arcott was so extreme I found it difficult to recognise their role in commercial sheep production. I visited Martin Kaiser a local lamb producer to see how Arcotts perform under intensive, commercial conditions. Ewes were kept inside and lambed every 8 months. The flock was rearing 2.5 lambs per ewe per lambing event and lamb sales were exceeding 3 lambs per ewe annum. Ewes did not show the typical “burn out” experienced by Finn x Dorset ewes kept under UK conditions and more surprisingly considering the initial breed makeup, lamb carcase quality was quite acceptable, with premiums regularly obtained.

Although the system was intensive it was still relatively low labour and feed costs were carefully managed, with a total mixed ration being fed. Biosecurity was tight and animal health status was extremely high. This production system (and producer mentality) was different to anything I had seen elsewhere - it was almost a new way of farming sheep.

The Rideau Arcott ewe is equivalent to the high performing Holstein cow. Under the right management it has the potential to markedly lift production, but producers must be technically astute and manage their inputs carefully. The breed could also have a roll within the UK as a sire of first cross females.

Canadian Arcott – Terminal Sire Line

The Canadian Arcott was developed as a terminal sire breeding line using Ile de France and Suffolk genetics. The Canadian produces fast-growing, meaty lambs that finish well at a range of carcase weights. However, in the absence of the show ring the breed has retained its easy lambing, low maintenance characteristics.

Marketing

Most composite rams are marketed from home, with a small number sold by auction to raise the profile of the flock. The reputation of these breeding lines is relatively good and it could be argued that the sale of composite rams is perhaps easier in Canada than in other countries, that have a longer tradition of sheep production. One unique selling point at Medicine Ridge is the tight flock biosecurity, which is a feature that merits a report in its own right.

Plans for the Future

Until now most of the carcase improvement work has been completed using raw ultrasound data measurements of muscle and fat. In the coming year a new organisation, Genovis, will become established to produce a home test programme to evaluate the genetic merit of Canadian breeding stock and produce EBVs for

economically important traits. The development of this service will be a major asset to this Albertan enterprise, which is already 10 years ahead of the average Canadian breeder.

Case Study IV. Katahdin (Composite Hair Sheep)

Breed Development

Katahdin sheep are a long established hair sheep composite (as opposed to those produced for wool) developed in the United States, by Michael Piel, an innovator and "amateur geneticist" who set out to establish a sheep enterprise for grazing power lines, which would require very little management. Katahdin were created in 1957 by back crossing the St Croix (hair) sheep with conventional meat breeds. In 1975 some Wiltshire Horn genetics were added into the mix, but this lead to a decrease in prolificacy and flightier disposition and the influence of the Wiltshire Horn has decreased as a result.

Does the Katahdin have a role within the UK?

The development of an "easy-care" strain of maternal sheep that expresses high reproductive efficiency, but lacks wool could improve the financial productivity of UK sheep production

In recent years the Katahdin has surged in popularity in the USA, particularly in drier environments. The limiting factor to its success in America is its small carcase size, but it must be remembered that the American market desires a 30kg+ carcase. When mated to leading UK terminal sires one would speculate that the first cross lamb would hit European carcase specifications.

Although the obvious advantage associated with the introduction of hair sheep genetics lies in their ability to produce a hair coat and shed their fleece, their true economic value is due to their early puberty, high fertility, prolificacy and increased lamb survival. There is also evidence these sheep are more resistant to internal parasites. At the USDA Nebraska these attributes are being enhanced in their composite hair sheep breeding programme through the introduction of Romanov (high prolificacy) genetics.

Breeding Programmes for Composite Hair Sheep

The challenge when incorporating hair breeds into a commercial breeding plan is that their use almost has to be all or nothing. In most cases the 1st and 2nd crosses by hair breeds (such as the Katahdin) will require shearing, even though the fleece is worthless. Grading up programmes need to be rapid.

The Katahdin was developed by trial and error, using detailed records. If such a programme were to be established today then measures of prolificacy, growth rate and shedding ability would be evaluated using BLUP technology to achieve a faster result. The new generation of Katahdin breeders, whilst publicly shunning the show ring, are actively using BLUP to improve growth and carcase traits - with an EBV for "ewe productivity" (kg lamb reared per ewe) recently being introduced.

Figure 2. Kathadin ram in Canada

Figure 3. Cashmore Park Composite ewe rearing triplets

2.3 Conclusions arising from these studies

Within these widely different flocks there are many common themes. Each breed has been developed to exploit a gap within their industry and obtained commercial acceptance over time. Two of these composites were developed through academic institutions, as many others have been in the past. It is interesting to speculate why these have been successful, where others have failed. Factors might include the level of industry communication, the appropriateness of breeding goals and the attitude of commercial breeders to change.

Composite strategies are clearly a more appropriate breeding solution for enhancing maternal attributes compared to terminal sires traits, because of the massive impact that hybrid vigour has on maternal traits of high economic importance, but low heritability.

Table 1. Impact of Heterosis (Hybrid Vigour) upon flock performance

Heterosis in the Crossbred Lamb		Heterosis in the Crossbred Ewe	
Trait	Heterosis (%)	Trait	Heterosis (%)
Birth weight	3.2	Fertility	8.7
Weaning weight	5.0	Prolificacy	3.2
Pre-weaning ADG	5.3	Body weight	5.0
Post-weaning ADG	6.6	Lamb birth weight	5.1
Yearling weight	5.2	Lamb weaning weight	6.3
Conception rate	2.6	Lamb survival	2.7
Prolificacy of dam	2.8	Lambs born/ewe exposed	11.5
Lamb survival	9.8	Lambs reared/ewe	14.7
Lambs born/ewe exposed	5.3	Weight lamb weaned/ewe	18.0
Lambs reared/ewe	15.2		
Wt of lamb weaned/ewe	17.8		

By contrast terminal sire breeders have already been successful in enhancing carcase attributes using EBVs and within breed selection. In many cases it is only when ram longevity, lamb vigour and lamb survival start to suffer that a composite approach is considered. Interestingly none of these breeders were interested in limiting the mature size of their maternal breeding line, although most acknowledged that this could become a challenge in the future.

None of these breeds would sell well on the basis of their phenotype and so every breeder has had to develop a marketing strategy to sell rams from home. This helps them to reduce costs of production and sell rams in working, rather than overfed condition. All of these breeders have developed a strong client base and achieve a high level of repeat sales.

Those breeders producing female breeding lines have realised their ability to sell “maternal rams” is limited while the demand for ewes is extremely strong. Commercial producers, once sold on the attributes of the maternal line, are not prepared to wait and grade up their existing flock using purchased rams. They want to buy the complete package through the purchase of ewes. Several companies have capitalised on this by marketing females sired by their rams, but produced on contract by other producers. These trading companies can be more lucrative than the breeding businesses from which they spring!

Section 3. Developing a composite breeding programme

Before embarking on the production and marketing of a new composite breeding line consideration must be given to the advantages and disadvantages associated with composite production and whether the breeding nucleus is to be closed or remain open.

3.1 Advantages of composite breeding:

There are a number of benefits that can be derived through the development of a composite breeding strategy compared to within breed selection.

- **Utilisation of heterosis (or Hybrid Vigour)**

Heterosis is the increase in performance achieved by crossbred progeny compared to the average performance of their purebred parents. The exploitation of heterosis is a unique attribute to crossbreeding strategies that enables improvement to be made in traits of low heritability, such as health, fitness and reproductive performance. The degree to which specific traits can be enhanced is shown in Table 1.

In general, crossbred animals tend to be more vigorous, more fertile and have a longer reproductive life than purebreds. The amount of heterosis locked into a composite breeding programme will vary depending on the length of time that crossing has taken place, the number of breeds involved and whether new purebred genetics are still being incorporated into the breeding programme.

- **Faster potential rates of genetic gain**

Within an open breeding programme[1] much greater selection differentials can be applied in the selection of breeding stock, with superior individuals being chosen from large performance recorded populations.

While a successful nucleus can be run with under 600 ewes, this ability to select rams from any recorded population widens the gene pool and greatly increases the potential rates of gain that can be achieved within the flock.

- **Integration of new genetics**

While a major gene or specific attribute may not be present within the initial gene mix, through the introduction of a new breed containing the gene and selective backcrossing the gene can become integrated into a composite population in a way that would not be allowed in most purebred breeding programmes.

- **Blending the breeds**

Crossing two breeds that possess high genetic merit for different traits and back crossing their progeny to retain these characteristics enables breeders to take advantage of breed complimentarity.

Alternatively the deliberate crossing of two breeds to produce progeny whose performance is intermediate between that of its more extreme parents can also result in improvements in efficiency.

- **Breeder mentality**

[1] Further details on open and closed breeding programmes are covered in Section 3.3

In many ways the greatest attribute to be derived from the development of composite breeding strategies is the mindset of the composite breeder. Without the shackles of breed society rules and regulations and with little regard for the show ring, composite breeders are pioneers that are not afraid to be different and try something new.

They tend to be great marketers, which is inevitable when they are selling a mongrel on what for many buyers is a leap of faith. Their breeding goals are driven by an understanding of the commercial producer and ironically their success, particularly with regard to the production of composite terminal sires, usually stems from the failings of the purebred, pedigree producer to address industry concerns.

In any other industry they would be “blue sky thinkers”, folk that think “outside the box”. In the sheep industry devoid of such clichés they may be regarded as a touch eccentric - but this doesn’t mean they aren’t successful!

3.2 Disadvantages of composite breeding programmes

- **Composite breeding programmes are more complex**

Breeders need to have a clear focus on what it is they wish to achieve. Composite breeding programmes are more complex and breeders must understand the relative economic merit of the production traits under selection and the relationships between them.

When working with several breeds, breeders have to be aware of a greater range of traits than would be required within conventional purebred programmes. Composite lines should be making faster genetic progress than conventional breeding programmes and as a result breeders must be aware at an earlier stage when their breeding goals require refining.

- **Composite breeding programmes require greater scale**

It would be hard to replicate the success of many of the leading composite breeding companies in the average UK pedigree flock of 50 ewes, due to the requirement to test mate new breeding lines and observe acceptable numbers of progeny to make valid conclusions. However, the size of the nucleus flocks at Rissington (2000 ewes) and Cashmore Park (2500 ewes) indicate such enterprises are not beyond the UK breeder providing they are run on a commercial basis.

- **Breeding potential can be more difficult to predict**

It is more challenging to produce EBVs for composite populations because the genetic correlations between traits can differ markedly in a composite population and heterosis will distort the EBVs produced for certain traits unless an appropriate BLUP model is used[2].

[2] Further information provided in Section 4.3.

- **Variation in appearance**

Composite production will lead to progeny that are more variable in appearance, particularly after two or three generations of crossing. This can lead to discrimination in the market place, where the appearance of a “mongrel” is undesirable. It is a source of debate as to whether the variation seen in type traits (head shape and colour) is as noticeable in traits of commercial importance such as carcase quality and indeed whether this matters considering the overall breeding merit of the parent stock.

- **Role of the purebred breeder**

In theory, composite breeders are still reliant on purebred breeders for the occasional infusion of purebred genetics to either increase heterosis or enhance specific traits. In reality, as has been seen in the pig industry, reliance on pure breeds decreases over time, particularly if the rates of gains achieved within purebred populations are significantly lower than those achieved in composite flocks.

3.3 Open and closed composite breeding programmes

Composite breeding programmes can be “open” to the incorporation of new genetics or “closed” with no new genetics being added to the strain after a certain point.

In the past many composite breeding programmes have been run as closed programmes. In theory after a period of intensive selection few animals outside the population will possess desirable genetics capable of competing with those in the new breeding line and even if they did, they would be hard to find without detailed recording keeping. The Rideau Arcott in Canada would be a great example, where it would now be difficult to find new animals outside the nucleus with similar levels of prolificacy. The introduction of new breeding stock creates an additional economic expense and a potential challenge with regard to maintaining flock health status.

Historically many composite breeders have strived to achieve phenotypic uniformity within their flocks. This has prevented the introduction of new genetic material and ironically may have lead to their downfall. The desire to breed sheep of a similar type and genetics will progressively reduce the levels of hybrid vigour within a closed population.

Modern composite breeding programmes tend to be open to the introduction of new genetics. This allows the deliberate integration of new genes (such as the Booroola (prolificacy) or Carwell gene (muscle depth) and, more importantly, it increases the selection pressure that can be applied within the breeding programme. Even the most dedicated Composite producer performance recording 500 ewes will struggle to make the same rates of gain if the population is closed compared to those breeders selecting into an open nucleus. Australian Texel breeders found this out to their detriment when their initial supremacy for muscle depth was eclipsed following subtle changes in the breeding policy of Poll Dorset breeders, who were selecting from a much larger population and eventually found superior genetics.

The “open” approach is not without risks. To start with it creates greater phenotypic variability within the flock, which is a hindrance in marketing stock and secondly a sizeable nucleus flock is still required to allow for a degree of failure, where inferior genetics are tested and have to be discarded. Many composite flocks have

deliberately developed “R&D” lines, containing second rate ewes that are used for test matings to new sires.

Section 4. Innovation that will drive composite production

New approaches to the evaluation of crossbred populations and the adoption of new technology could assist composite breeders to become established within the UK, as well as driving change within purebred breeding programmes.

4.1 Across breed EBVs

For the first time in 2000 the EBVs produced for terminal sires in Australia were analyzed “across breed”. Across breed EBVs create a new level of competition, enabling commercial ram buyers to compare the performance of animals in different breeds. This has lead to increases in rates of genetic gain.

Commercial producers find across breed EBVs easier to interpret and the use of EBVs to make commercial decisions increases as a result. Supply chains are already using lists of elite animals (across different breeds) to locate favoured seedstock producers.

This approach has also changed the attitudes of some breed societies, which developed grading up programmes that enable breeders to “mine the genetic wealth of other breeds”. The development of composites has gained commercial acceptance through the availability of across breed EBVs that enable purebred and crossbred sheep to be directly compared.

4.2 Breed comparisons

The ability to compare breeds is underpinning research in the USA. An evaluation of the attributes of different breeds reared under a common environment is being completed at the Clay Centre, Nebraska. Nine leading breeds have been mated to a common flock of ewes. Lamb survival, growth and carcase attributes including meat quality (sensory traits) have been compared through to slaughter. The breeds involved were general purpose (Dorset), maternal (Rambouillet, Finnsheep, and Romanov), paternal (Clay Centre Composite, Suffolk and Texel) and hair (Dorper and Katahdin). Recommendations arising from this project have direct relevance to both pure bred and crossbreeding programmes.

4.3 Evaluating crossbred populations – Accounting for heterosis

Theoretically the BLUP models used within sheep breeding programmes can be adapted to take into account hybrid vigor between breeds, so that EBVs simply relate to the additive genetic variation between individuals. This improves the accuracy of a crossbred animal’s EBVs and, more importantly, prevents their parents EBVs from becoming distorted.

In practice this is not being done overseas, because the most important across breed evaluations currently focus on growth and carcase traits, which are less highly influenced by heterosis.

4.4 Genetic parameter updates

When evaluating a dataset containing information relating to composite breeds it is important to consider whether the genetic parameters being used within the model are appropriate. This can be more complicated than it would first appear.

For example, there is a tendency within the UK to find a positive correlation between growth rate and prolificacy within pure breeds of sheep. However, within the Polypay breed the genetic association between prolificacy and growth rate is negative, which can be attributed to the introduction of Finn genetics. Geneticists need to be aware that unexpected genetic relationships can arise within composite breeding programmes and take these into account in the production of EBVs

4.5 Breeding software

As the number of traits that are incorporated into breeding programs increases, breeders require better tools to support them in making the right breeding decisions. Breeding software that produces recommended mating lists are useful as a teaching tool, to understand the consequences of making certain selection decisions and as an advisory tool to ensure appropriate mating decisions are made.

An example of this type of software is “Total Genetic Resource Management” (TGRM), which is available through Lambplan, Australia. TGRM reviews every possible mating decision within a flock and creates recommendations based on predefined breeding goals, the need to maintain genetic diversity and constraints relating to inbreeding and logistical issues (such as the size of the mating group).

Recent developments have enabled TGRM to be used across flocks, where it can be programmed to exploit heterosis within the creation of a composite line. This is a significant benefit for composite breeders, particularly in a country such as Australia where one breed, the Poll Dorset (and its crossbred relative the White Suffolk), is dominating the terminal sire market - making it difficult to increase or even maintain high levels of heterosis while increasing rates of genetic gain.

4.6 Integrating molecular and quantitative genetics

A number of genetic markers and genes have been identified that influence reproductive rate (Booroola & Inverdale), carcase quality (Carwell, Callipyge and Myostatin) and disease resistance (Scrapie) in sheep. This list will expand considerably over the next few years with knowledge gained from other species.

A review of their application is outside the scope of this study, but it must be recognized that the composite breeder is better placed to exploit molecular developments than the breeder of purebreds. Put simply, the composite breeder can openly integrate known genes into their flock, whereas the conventional purebred producer can’t.

The challenge for all sheep breeders is to find out how they can merge the use of molecular and quantitative genetic techniques into a simple, cost effective strategy that will generate faster rates of gain than the use of quantitative approaches alone.

4.7 Analysis of commercial carcase data

VIASCAN, a new automated way to assess carcase quality using visual images processed via a computer, is used overseas (Australia and New Zealand) and is currently being tested in the UK. Experience overseas indicates that this technology will create an additional catalyst for change amongst ram breeders. VIASCAN feedback enables commercial producers to realize the importance of “lean meat yield” and lamb producer groups will be able to benchmark the performance of stock between farms. The ability to compare carcase data between farms will create a competitive edge for those breeders whose rams perform well. It should lead to more commercially focused breeding decisions, particularly with regard to the selection of genetics that will perform under a specific environment.

All of these commercial drivers play into the hands of the composite breeder, who can use data obtained from VIASCAN to enhance their breeding programs and to promote their genetics. Composite breeders can change their breeding goals more rapidly in response to feedback from the meat plants than conventional, purebred ram breeders.

4.8 Achieving scale – The use of parental genotyping and EID

Most composite breeders can grow the size of their flocks to a much greater scale than purebred breeders, because the real financial value of their ewe flock is usually little above commercial market value and their breeding lines don’t require such a high level of inputs; having been indirectly selected for ease of management under commercial conditions.

One of the limiting factors that usually prevents the expansion of composite flocks (and the rates of genetic gain achieved within them) is the size of their breeding nucleus, which is often restricted by the availability of staff at lambing time to tag lambs to record their pedigrees. By blood sampling stock ewes, rams and lambs within the flock, it is now possible to predict lamb pedigrees using DNA profiling techniques. This approach negates the need for additional labour at lambing and allows multi-sire matings (which can increase pregnancy rates). Some farms have increased lamb survival, as the disturbance of ewes and lambs at parturition is reduced.

Once the DNA profile for an individual animal has been established the ability to apply molecular genetic techniques to track individuals carrying specific genes is relatively straightforward. This secondary benefit will have much wider implications for breeders in the future.

Combining the use of parental genotyping with electronic identification (EID) systems and mobile handling systems to capture data quickly has been critical to the rapid expansion of many of the New Zealand composite companies.

4.9 Conclusions: Will composite breeders take up these new technologies?

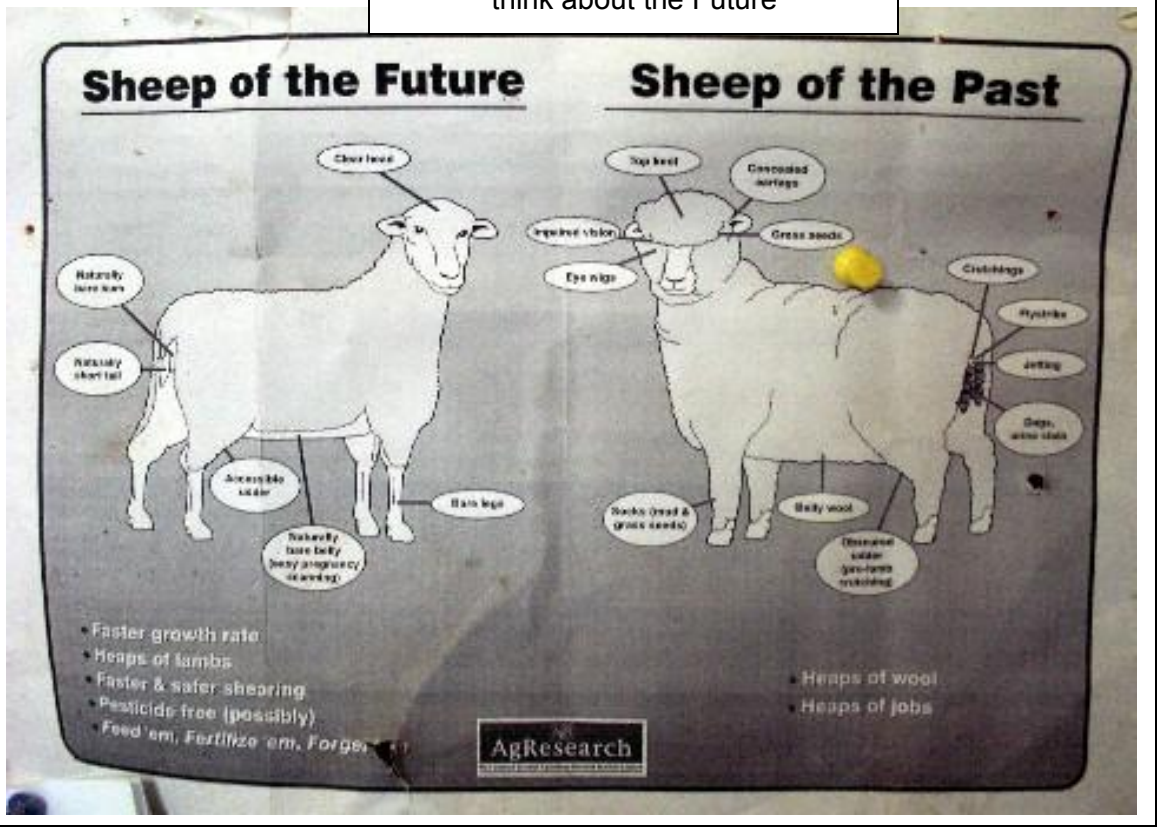
The evolution of genetic evaluations to compare and contrast pure and crossbred populations against one another in a robust and fair manner is a tremendous asset to the industry. While assisting the purebred producer to identify their weakness, it allows composite breeders to make better breeding decisions and it helps commercial producers to locate the right breed and breeding stock for their system.

The adoption of new reproductive and molecular technologies will depend on the cost benefit arising from the use of these technologies, which will be driven to a large extent by commercial demand.

As observed by Rob Banks in Australia, in any industry where services and products can be compared on the basis of objective attributes, competition between those services and products changes the behavior of businesses towards innovation and customization. He states that terminal sire ram producers are no different. Australian ram breeders are starting to behave like ram breeding businesses, seeking new technologies at a faster rate and focusing on customer requirements.

In the UK increasing competition between ram producers in an over supplied market should prove a sufficient catalyst to drive innovation, providing that breeding businesses are large enough to carry these costs, are financially sound and see a positive return on their investment.

Figure 4. Encouraging Breeders to think about the Future



Footnotes to diagram

- *Faster growth rate*
- *Heaps of lambs*
- *Faster & safer shearing*
- *Pesticide free (possibly)*
- *Feed'em, fertilise 'em, forget em*
- *Heaps of wool*
- *Heaps of jobs*

Section 5. Successful breeding businesses

5.1 Blueprint for success for sheep breeding businesses

Over the course of this study I was privileged to visit a large number of successful breeders. From these visits I have endeavoured to summarise those areas in which I believe a successful, modern breeding business must excel – with a view to publishing them on my return to the UK.

1). Understand the customer.

Breeders must appreciate the sheep production system into which their rams are expected to work and align their breeding goals with those of their clients. Understanding whether the customer has a commercial or pedigree flock will also indicate their potential spending power.

2). Present an appealing product

Despite the availability of EBVs to promote breeding potential, 95% of ram buyers still require an animal that has a degree of visual appeal. A balance must be struck to present rams that look their best, which will thrive in a harsh nutritional environment. Breeders should avoid traits that are visually unappealing, such as daginess or open fleeces, if it is a concern to their clients.

3). Customer service - Remember how your flock will be remembered!

Repeat business is vitally important. Producers must provide after sales care that ensures the ram buying experience is hassle free and that new rams have a long working life in their new flocks.

Breeders might consider looking after purchases until they are required for use, providing management notes to accompany them or supplying feed to help them settle to their new diet. However, these costs must be recouped within the value of the sale. Customers appreciate breeders that will stand by their stock, enabling non-performing rams to be exchanged without query.

4). Breeder personality counts

Many producers will purchase from a particular stud because of the rapport they have with the breeder. Successful breeders must demonstrate trust and confidence in the product, enthusiasm and optimism about the industry and show authority and knowledge with regard to breeding strategy. In large breeding companies overseas a dedicated salesman is employed to complete this task.

5). Communicate with your clients

Customers must be kept informed about what has been achieved during the year. This can be done through newsletters (paper or electronic), ram catalogues and open evenings. Collect customer feedback to monitor success and identify where breeding goals might need to change. Positive feedback is also useful for promotional purposes.

6). Reduce financial risks

Secure regular and repeat sales off farm to set against the investment in the breeding enterprise. One way to do this is through the development of a contract to produce a specific number of breeding animals. Mixed farms can offset risk against other on-farm enterprises.

7). Innovate and add value to breeding stock

Few breeders can compete solely on price, so they need to have a product that is different and hence worth more money to the potential investor.

Compared to other producers this may mean:

- Achieving faster progress in certain traits
- Selection for new traits (worm resistance, footrot resistance)
- Producing animals that are reared in a manner that increases their lifespan (e.g. rams reared on grass)
- Unique features such as polling or stripping tails.
- Unique health status

This might mean producing different strains within the same population for different clients.

8). Consider other income streams

The sale of rams can be challenging, sometimes the sale of semen, in-lamb ewes or ewe lambs can prove easier and more profitable.

9). Be a great commercial sheep producer

Breeders that run large commercial flocks or run their ram breeding flock in a commercial manner tend to place greater emphasis on commercial breeding objectives. Culling regimes are more rigorous in commercially managed flocks and breeding lines become more “robust” having been required to perform in an unpampered environment. A commercial approach tends to increase customer confidence.

Those flocks that are run in such a commercial manner that they could still make money if all of their lambs were sold for slaughter are financially robust and can be competitive on price.

10). Know your costs of production.

Set targets for financial performance. Plans should take into account the relative financial benefit of using new technologies, such as accelerated breeding programmes (AI /ET/JIVET) or molecular techniques (gene markers, parental genotyping). An understanding of production costs will help to establish appropriate prices for breeding stock.

11) Breed for the future

Staying a step ahead of your clients with regard to their breeding needs will ensure future success. Examples from overseas include the development of shedding attributes, polling, the integration of prolificacy genes and changing carcase attributes to meet the needs of the retailer (i.e. shelf life).

12). Set clear breeding objectives

Understand what you are trying to achieve over the next 5 –10 years and don't deviate from this path without good reason. Discuss these objectives with your staff and clients. Recognise which traits can be realistically enhanced through within breed selection and which are best enhanced through crossbreeding.

13). Get good advice

Before embarking on an ambitious breeding programme get good genetic advice. A geneticist should be able to say whether your breeding plan can be completed in the manner and timescale you had intended and whether there are better options that should be considered.

14). Collect good performance data

As breeders and buyers place ever greater reliance on the EBVs produced within a breeding programme the quality of data collected is really important. Consider whether additional data can be collected and incorporated into the analysis at little extra cost.

15). Beware of high prices

Ironically the trade of high priced breeding stock can be catastrophic for a breed. Few £25,000+ rams ever get culled after a single season. In a commercially managed flock, where breeding stock are valued at little more than commercial value, culling decisions are rapid and so are rates of genetic gain. Reluctance to drop overpriced, poor quality genetics from a breeding programme can set a breed back decades.

16). Eliminate unnecessary costs

Alleviate production costs if they don't add value to your system. For example, some breeders need to question whether the time and expense of attending shows and sales is good value for money.

17). Get big or work with others - because population size matters

The size of the breeding flock has a large impact on both potential rates of genetic gain and the financial performance of the business. If it is not possible to increase the size of the flock then lambs should be performance recorded as part of a group breeding scheme. This provides access to a wider gene pool from which selection decisions can be made and it can increase buying power.

18). Successful marketing strategies are vitally important

Invest time and money in marketing your flock if you wish to succeed. Create an image of yourself and your flock that will support your sales activities. Communicate clearly to help your clients to understand the features of your breeding programme and more importantly the financial benefits to them.

19). Protect your genetics

Breeders must consider whether their competitors can access their best genetics at commercial prices. Composite breeders are the greatest culprits for poaching genetics and as a result they are probably the most protective too! Large companies often pick rams on behalf of their clients to alleviate this risk, so their clients aren't knowingly aware if they are in possession of a sire in the top 1% or top 50% of the flock.

20) Take control of ram sales

Auctions can prove to be a high cost, high risk way to sell sheep. In Australia and New Zealand on-farm sales are important and they negate the inevitable overfeeding of rams that takes place at mixed vendor sales. Many sales are conducted as auctions, so the auctioneer still has an important role within these transactions.

Helmsman auctions provide an alternative way to offer rams for sale off farm. This system enables buyers to bid on different lots simultaneously. Breeders need to add value to their ram sales through the provision of hospitality and by giving buyers plenty of choice.

Electronic auctions are becoming more popular as commercial buyers place an increasing amount of trust on both the supplier of breeding stock and their EBVs. This approach is used at the Clay Centre, Nebraska, as a way to market rams without breaking biosecurity guidelines.

21). Choose your breeding partners carefully

There are many advantages in working with others to increase the size of the recorded population, but breeders should choose their partners carefully. It is dangerous to have another breeder in the locality that possesses the same genetics.

It should also be remembered that the success of a group breeding program will probably be judged by the performance of the worst flocks in the group, not the best ones.

22). Not every breeding decision can be based on EBVs

Although Robert Bakewell was a very successful ram breeder, his bachelor status wouldn't help him today. Family support underpins the success of most breeding businesses and the importance of a supportive team shouldn't be underestimated.

5.2 Conclusions: "Successful breeding businesses"

None of these points are rocket science – in fact I scribbled most of them on a set of beer mats in a small bar in Wyoming at the end of a particularly long drive. What they show is that success is dependent on a large number of factors. As with any business, the ability to cost effectively, produce and market the right product has a major impact on the success of the enterprise.

Out of all of these factors the one that strikes me as the most important is the ability to market the product, it won't be the breeder with the best animals that has the most successful business – it will be the one that is best at marketing them.

Section 6. Impact of composite sheep within the UK

6.1 Composite sheep within the UK

Tremendous rates of genetic gain have been achieved in UK sheep breeds through within breed selection for traits such as growth rate, muscling and leanness; and to a lesser extent maternal ability and prolificacy. It could be argued that our terminal sire breeds lead the world, so what role do composites have in the UK?

The exploitation of composite breeding theory is a proven way to enhance the productivity of sheep production. The challenge for UK producers is to recognise where it should be exploited and where within breed selection can meet the industry's breeding needs.

Composite breeding will be of use within the UK where:

- Faster rates of genetic gain are achievable through composite production in comparison to the purebred sector, because undue emphasis is placed on non-economic selection criteria, such as show traits.
- Where breeding decisions within the purebred sector are to the detriment of commercial producers.
- New traits are identified that have to be incorporated from another breed, such as the transferral of shedding ability from African hair sheep into British native breeds.
- The requirement to improve lowland maternal breeding lines can't be achieved using the current stratified approach to the breeding of first cross (mule and halfbred) ewes on hill farms.

  This might arise where:

  - Economic factors lead to the destocking of hill farms.
  - Commercial producers believe that the first cross ewe is not improving, with few hill and longwool breeders embracing progressive breeding strategies.
  - Issues relating to flock biosecurity, organic status or replacement costs favour the retention of homebred female replacements.
- There is an industry requirement to enhance traits that are difficult to improve through within breed selection. Examples might include lamb survival, ram vigour and ram longevity within terminal sire breeding lines and ewe longevity and fertility within maternal breeding lines.
- Retailers seek to control the supply of a specific breeding line within the supply chain to generate a uniquely branded product.

With specific regard to the terminal sire sector the success of composite breeding strategies will be as much due to the failings of purebred breeders to address issues of commercial concern, as it will to the genetic superiority of composite animals.

6.2 Should British breeders import or innovate?

British ram breeders looking to adopt composite breeding strategies have two options, they can import genetics from overseas or create their own breeding lines using British genetics. The pros and cons of these two approaches are as follows:

Advantages of importing overseas genetics:

- Access to an established, stabilised, large scale breeding programme
- Potential marketing support from an established breeding company
- Marketing edge through the importation of a “new” breeding line
- Ability to control the gene pool and avoid imitation by other breeders
- Access to new traits

Disadvantages:

- Overseas breeding goals will differ to those in the UK
- Unknown performance of overseas genetics in the UK environment
- Cost associated with buying genetics, artificial insemination and embryo transfer
- Health protocols restrict importations
- Danger of “buying blind”
- Limited choice following pre-selection based on scrapie genotype

The advantages of creating a UK composite:

- Complete control over the breeding programme
- More cost effective (depending on importation costs)
- Better understanding of the breeding potential of foundation animals

Disadvantages:

- Time taken to establish the breeding line
- Major marketing effort required
- Ability to achieve sufficient scale
- A significant number of UK breeders are already selling cheap crossbred rams and the resulting perception that the native crossbred is a low value product

Undoubtedly both approaches have something to offer, considering the genetic bases that exist at home and abroad. A different business model will be required depending on the approach that is used. However, where new traits are of interest that don’t exist within the UK the need to import new genetic material is inevitable.

6.3 Footnote

In the last 12 months one New Zealand company has seized the initiative and imported composite sheep genetics into the UK. Breeding Vision, a newly established British breeding company, has created two nucleus flocks, which currently number over 300 head. Last year over 100 composite rams were placed on farms, making it one of the UK’s largest breeding companies in a single season. In Autumn 2006 over 1000 embryos/inseminations took place to produce breeding stock for producers supplying Marks & Spencer.

Section 7. Conclusions with reference to the UK

1. The performance of the UK sheep industry could be enhanced if British ram producers embraced some of the breeding and marketing strategies utilised by composite breeding companies overseas.

2. Composite breeding theory has much to offer the producers of maternal breeding lines, where breeding goals are complex and hybrid vigour can be exploited for economic gain.

3. Composite terminal sire breeding lines will only be successful where established breeds fail to respond to change and address areas of concern to commercial producers.

4. Open nucleus composites are being widely used overseas as they generate faster rates of gain and are less likely to produce inbreeding depression. However, the composite animals bred in an open breeding programme are more variable in appearance and require greater marketing support.

5. The short term success and hence long term viability of composite breeding companies within the UK will be as heavily influenced by the way animals are promoted and marketed, as it will their overall genetic merit.

6. The provision of across breed EBVs (Estimated Breeding Values) to terminal sire producers would support the development of composite flocks based on British genetics.

7. While the threat posed by overseas breeding companies is acknowledged, the competition they create is to be welcomed, as it will encourage ram breeders to become more innovative and customer focussed.

Figure 5. NZ Composite embryo lamb imported into Buckinghamshire, UK in 2006

Appendix 1. Tour itinerary

In October 2005 I visited Australia and New Zealand and in June 2006 I visited the USA and Canada. The table below briefly indicates people and events that I saw and the reasons for my interest in making that visit.

I am indebted to these people for sparing the time to see me, if I have missed anyone from the list I sincerely apologise.

Australia

Lynton Arney (N. Sch)	Border Leicester and Border Leicester Composite Studs
John and Annie Hughes	Wiltipoll Breeders. National Wiltipoll Open Day: Speakers included Scott Dolling – Polling and Shedding Genetics San Jolly – Nutrition for Easycare Sheep
Kym and Kathy Staude	Dorper, Coolallee and Dohne Merino Studs Ram Sale and Flock Visit
The Clothier Family	Poll Dorset, White Suffolk, Merino and Boroolla Leicester Stud Attended Ram Sale and visited Narracorte Livestock Market Farm Tour looking at pasture management and soil science
Australian Nuffield Conference	The conference was on “Risk Management”. A series of papers were presented by industry leaders and Nuffield Scholars completing their tour
John Keiller	Cashmore Park Composite Breeding Stud. Composite flock possessing maternal and terminal sire breeding lines
Steve Parker	Texel Breeder. A local ram sale was also attended
Robert Kelly	Fine Wool Merion Stud and demonstration farm
Richard Apps	Lambplan based at Armidale. Time was also spent with Daniel Brown, ABRI Geneticist
Robert Mortimer	Centre Plus Merinos. A Merino stud seeking to modernise the Merino industry. Time was spent discussing wool production, maternal behaviour and TGRM (Total Genetic Resource Management)
Australia National Fieldays	Event held at Orange, New South Wales. Time was spent discussing Boer Goat Breeding, Progeny Tests, Sheep Handling Equipment and Fleece Testing Machines

New Zealand

Richard Warren	Romney Flock and part of a Romney Improvement Programme
Derek Daniel (N. Sch)	Wairere Romney & Composite Flocks
Bill Hume	Romney Flock and part of a Romney Improvement Programme
Jeremy Absalom, Rissington Breedline	Breeding Company developing Composite breeding lines and seeking to integrate these into the supply chain.
Geoff Nicol and John Rendal	Landcorp Geneticists overseeing the Breeding Policy for Landcorp farms
Sally Hobson, (representing SIL)	Time was also spent with Chris Morris, an expert on selecting for worm resilience and worm resistance
John Hepburn, Animal Breeding Services	Visit to an AI Station in Hamilton

USA

Dwight and Sharon Tisdale	Polypay Breeders (the Polypay is a Composite Strain). A feedlot and stud flock were visited
Clay Centre	Kreg Leymaster and Larry Kuen (Geneticists specialising in Breeding Strategy). The research flock contained several Composite lines, including Romanov and Katahdin genetics. Meetings were held to discuss cattle breeding, meat quality, food safety, Scrapie genetics
Iowa Sheep Event	Sheep show with technical presentations on feed lotting, health and breeding.
Bob Kimm	Suffolk breeder
Carl Gnapp	Katahdin (Hair Sheep Composite) Breeder
Cindy Wolfe and Kelly O'Neil	Siremax breeders. Siremax is a terminal Sire Composite line developed over the last 15 years
Janet McInally	Poll Dorset and Poll Dorset Composite breeder infusing Booroola genetics into the maternal breeding line to enhance prolificacy

Canada

Ian and Deb Clark	Canadian Rideau (terminal sire line), Rideau Arcott (Maternal line), Charollais and Ile de France.
	Genovis – The new Canadian performance recording service
Martin Kaiser	Commercial producer with Rideau Arcott
Ian Sward	Katahdin breeder
Ileana Wenger	OC Flock Management – providing AI and ET Services to sheep producers. Breeders of Charollais and Romanov sheep