Thinking about breeding differently

By George Fell
Lutz Bunger
A 5 breed cross started by Henry Fell in the 1960’s

Using Suffolk, Poll Dorset, Ille de France, Berrichon de Cher and Charollais

Aim:
• To create a commercial ram for commercial lamb producers that is fit for purpose
• Grass based system

After 50 years of breeding, what’s next to maintain genetic progress??
Genetic gain in the Meatlir
Genetic gain in the Meatlir

Meatlinc Genetic Trends 2013
Muscle Depth and Fat Depth

Average EBV for Carcase Traits (mm)

Year

Fat Depth EBV
Muscle Depth EBV
Genetic gain in the Charolais

Charollais Genetic Trends 2013
Eight Week Weight and Scan Weight

Average EBV for Growth Traits (kg)

Year

Eight Week Weight EBV
Scan Weight EBV
Genetic gain in the Charol

Charollais Genetic Trends 2013
Muscle Depth and Fat Depth

Average EBV for Carcase Traits (mm)

Year


Fat Depth EBV
Muscle Depth EBV
Genetic gain in the Texel

Texel Genetic Trends 2013
Eight Week Weight and Scan Weight

Average EBV for Growth Traits (kg)

Eight Week Weight EBV
Scan Weight EBV
Genetic gain in the Texel

Texel Genetic Trends 2013
Muscle Depth and Fat Depth

![Graph showing the trend of average EBV for carcass traits (mm) over years from 1999 to 2013. The graph compares Fat Depth EBV (blue line) and Muscle Depth EBV (red line).]
What would be the new breeding goal?

- The aim is still the same - commercial rams for commercial lamb producers - growth rate/muscling/EMA/muscle shape, lower external fat, length, vertebra number, ease of lambing/from forage

- Can we take some of the best genetics from other breeds?
- Can we incorporate them into the existing Meatlinc breeding program?
- Can we select for the traits we want?
- Can we create a genetically superior ram for the benefit of our customers?

What was required - funding and genetic evaluation and analysis
• Funding announced for ‘Sustainable Protein Production’
• Genetic improvement in livestock was within scope
• Funding of up to 50% available
• A collaboration agreement had to be produced between industry (Meatlinc) and academic (SRUC)
• In Autumn 2011, Meatlinc and SRUC were awarded 50% grant funding over a 5 year project
Gene pool fishing by out-crossing and back-crossing cycles in one Terminal Sire Sheep Breed-Blueprint for Terminal Sire Breeding in the UK and beyond

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(Geneticist at SAC/EGENES)

Shepherd
(MeatLinc)
CT work at SRUC aims mainly at the Terminal Sire breeds

410,000 rams used annually
Introduction

• ~90 recognised breeds of sheep in the UK (Pollott & Stone 2006), which might be said to harbour all existing ovine alleles and therefore present a vast gene pool.

• Large variation between these breeds is an unemployed resource.

• The UK’s (or World’s) many sheep breeds and the variation between them should be cherished.

• Conservation needed: While current economical conditions may dictate the use of relatively few breeds (probably not all but many!) need to preserved.

“QTL studies” find QTL for in a chromosomal region
If only 1 gene or a few - no problem MAI can do it!

- GAS Marker
- "The Gene"
- Two flanking MAS Markers
- "The Gene"

**Figure 2.** Distributions of QTL effect from pig and dairy experiments. Magnification of distribution from effect = 1 to 1.5σp (B).
The principle of MAI

Target mouse line: red

\[ g_i = \frac{1}{2^i} \]

\[ r_i = \frac{1}{2^i} \]

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50.0% 50.0%
25.0% 75.0%
12.5% 87.5%
6.25% 93.8%
3.13% 96.9%

99.2% “red”
The problem:

- Too few QTL, GWAS studies → only a few genes/QTL known
- Too many genes affecting traits of interest (infinitesimal model)
- Too expensive, too much labour
• Impressive rates of genetic gain have been achieved in UK terminal sire breeding programmes through selection on the Lean Index

• High performance in the different TS Breeds at least partially determined by different alleles and different allele frequencies

• Whereas other species and countries (e.g. NZ moved to ‘across breed’ or ‘multibreed’ genetic evaluations) the rigid breed standards and hanging on to the ‘breed concept’ in the UK hinders or slows down such approach

• Hypothesis: (Repeated?) Fishing) in the gene pool of other developed high performance breeds by crossing and backcrossing provides higher genetic gains than purebred selection
• Crossbreeding is often done
  (i) to use heterosis/hybrid vigour
  (ii) with the intent to ultimately creating a new breed

i. Heterosis. This cross needs to be produced continuously to use the produced heterosis and requires the parental breeds/line to be maintained. Such systems are adopted in the pig breeding

ii. An alternative approach is out-crossing to other high performance breeds followed by inter-se matings and repeated backcrossing under high selection pressure, which allows to maintain a breed with its typical characteristics whilst making larger breeding progress compared to purebred selection
Deliverables:
- genetically improved terminal sire sheep breed
- demonstration on how to achieve substantial extra selection gains
- blueprint for other breeds about “exploiting genetic variance in other breeds”

How:
- Outcrossing followed by inter-se matings and repeated backcrossing
- “Gene Fishing with a dense net” of phenotyping based on non-invasive, high accuracy (computed tomography [CT])

Aim:
- Identify carriers of valuable genetic variants relating to production efficiency in other breeds
- Increase their frequencies in the target terminal sire breed,
- Enrich the gene pool of the target terminal sire breed
- Demonstrate their superiority
Experimental plan (slides 8 and 9)
Year 1

Year 2

Year 3

Year 4

F1 (MT)

F1 (MC)

F2 (MTC)

F2 (MTC)

F3 (MTC)

F3 (MTC)

Inter se
Plus F1 x F2
→ F3

BC
→ F4

Inter se
→ F5

ML

F4 (MTC)

F4 (MTC)
Validation trial at the end
Acknowledgements