Breeding for resistance to footrot in UK sheep

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UK Government & Industry - funded project

"Breeding for resistance to Footrot, combining molecular and phenotypic approaches"

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"Breeding for resistance to Footrot, combining molecular and phenotypic approaches"

Aim: Investigate the 'best' way to breed for footrot resistance in sheep

Aims of this paper

To:

- Evaluate use of foot scoring (screening) as phenotypic tool in sheep breeding
- Estimate the genetic properties of footrot in UK sheep (Blackface, Mule, Texel)
  - Heritability - Repeatability
- Estimate genetic parameters (rg, rp) with other performance traits

Background to Footrot

- Main cause of lameness
- Endemic disease caused by *Dichelobacter Nodosus*
- Major problem for UK sheep
  - lost productivity
  - control is labour intensive
  - visible welfare problem
- Costs £24M+ p.a. to UK sheep industry*

Need for an 'alternative' strategy for long-term control

* Nieuwhof & Bishop 2005 Animal Science 81:23-29

Location of participating farms

27 farms across UK – experimental & commercial flocks

Key
Orange = Texel
Blue = Blackface
Pink = Mule
Red = Texel, Mule
Green=Texel, Blackface

Blackface

Mule (ewe)

Texel

Data collected – from flocks with known pedigree (55,468 actual foot scores)

Texel

2006 & 2007

17 flocks

5,893 records

Prevalence
29% (‘06), 18.5% (‘07)
27% (lambs)

Blackface

2005 & 2006

5 flocks

6,132 records

Prevalence
17% (‘05), 18% (‘06) ewes
34% (‘05) lambs

F1 “Mule” (ewe)

2005 & 2006

3 flocks

1,842 records

Prevalence
58% (‘05), 43%(‘06)

Footrot score validation

Score 0

Score 1

Score 2

Score 3

Score 4

Footrot score validation

Is foot scoring a useful phenotypic tool ?

- 100 ewes from flock with history of footrot
- 2 scorers - each independently scored sheep twice
  - 400 'ewe' records and

⇨ 1600 'foot' records

Foot score validation - Aims

- Test repeatability of scores
- Test for differences between scorers
- Account for other influences on foot score
- Ultimately..
  - Determine if use of score is a reliable and repeatable method of scoring foot lesions

Results*

- Prevalence >0 = 15%, >1 = 12%
- Both scorers agreed fully 71% of the time
  - 91% for 'sum of scores' +/- 2
- Correlation between scorers = 0.87
- Correlation between scoring occasions = 0.87
- Older ewes had higher scores (P<0.01)
- Grazing paddock important (P<0.01)
- Hind hooves had higher scores (P<0.05)

  - NB implications for data analysis

*Conington et al., 2008 Vet. Res. Comm. ISSN= 0165-7380 (Print) 1573-7446 (Online).

Is footrot heritable?

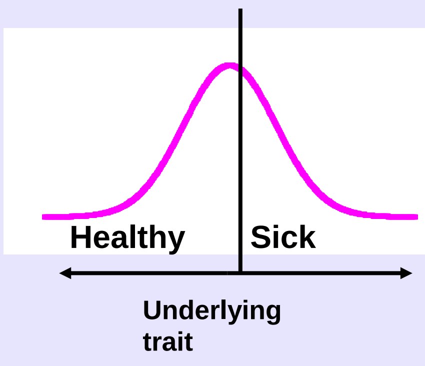
- Which trait?
  - Presence or absence (0/1)
    - Footrot (FR)
    - Severe footrot (FR2-4)
  - Sum of scores
  - Maximum score
  - Number of feet affected
  - etc.......

Estimating Heritabilities

- What trait?
  - Presence or absence (0/1)
    - Footrot (FR)
    - Severe footrot (FR2-4)
- Method of analysis?
  - Observed
  - Underlying

Estimating Heritabilities

- What trait?
  - Presence or absence (0/1)
    - Footrot (FR 1+)
    - Severe footrot (FR2+)
- Method of analysis?
  - Observed
  - Underlying 'Threshold'



Statistical methods – ewe data

- Model
  - Flock / management group, scorer, scoring occasion, ewe age, litter size reared
- Genetic
  - Sire model + logit link function + permanent environment

No. of observations for h^2 estimates

	2005		2006	
	Score 1	Score 2	Score 1	Score 2
Mule ewes	686	529	398	229
Blackface ewes	1353		2987	

Results - Heritabilities

		Blackface ewes	Mules
Footrot (1+)	Underlying	0.19 (0.07)	0.12 (0.06)
	Observed	0.08 (0.02)	0.11 (0.06)
Severe Footrot (2+)	Underlying	0.26 (0.11)	0.19 (0.10)
	Observed	0.05 (0.02)	0.13 (0.07)

Results - Heritabilities

		Blackface ewes	Mules
Footrot	Underlying	0.19 (0.07)	0.12 (0.06)
	Observed	0.08 (0.02)	0.11 (0.06)
Severe Footrot	Underlying	0.26 (0.11)	0.19 (0.10)
	Observed	0.05 (0.02)	0.13 (0.07)

Results - Repeatability

		Blackface		Mule	
		Perm. Env.	h^2	Perm. Env.	h^2
Footrot	Underlying	0.04	0.19 (0.07)	0.10	0.12 (0.06)
	Observed	0.00	0.08 (0.02)	0.02	0.11 (0.06)
Severe Footrot	Underlying	0.07	0.26 (0.11)	0.14	0.19 (0.10)
	Observed	0.01	0.05 (0.02)	0.01	0.13 (0.07)

Repeatability range 0.06-0.33 (BF), 0.13-0.33 (Mule)

Are heritabilities affected by Prevalence?

Trait	model	All data	Prevalence	
			High	Low
Number		2987	1194	1793
Prevalence		0.18	0.30	0.10

Are heritabilities affected by Prevalence?

Trait	model	All data	Prevalence	
			High	Low
Number		2987	1194	1793
Prevalence		0.18	0.30	0.10
Method of analysis				
	Observed	0.10 (0.03)	0.16 (0.06)	0.06 (0.04)

Are heritabilities affected by Prevalence?*

Trait	model	All data	Prevalence	
			High	Low
Number		2987	1194	1793
Prevalence		0.18	0.30	0.10
Method of analysis	Underlying	0.21 (0.10)	0.36 (0.14)	0.06 (0.13)
	Observed	0.10 (0.03)	0.16 (0.06)	0.06 (0.04)

***Nieuwhof et al., 2008 Animal 2:9: 1289-1296**

Lamb data – heritabilities

Blackface n= 1199
(2 flocks), 2005
Ave. age = 125d
Prevalence = 34%

Texel n=1825 (17 flocks), 2006 & 2007
Ave. age = 158d
Prevalence = 27%

Statistical methods – Lamb data

- Model
  - Gender, flock, scorer, score date (days from 1st Jan, covar)
    - * (Litter size born/reared and year **not** significant)
    - * Male lambs almost twice FR scores of females
- Genetic
  - Sire model (+ logit link function for underlying analyses); bivariate - animal

Results: Lamb footrot - heritability

	Blackface h^2 (s.e.)	Texel h^2 (s.e.)
Footrot 0/1 Underlying	0	0.25 (0.102)
Severe Footrot 0/2+ Underlying	0	0.24 (0.12)
Observed	0	0.25 (0.084)

? ? May be due to differences in age?.. or time lapse from weaning, to when hooves were scored ??

Footrot correlations with performance

Texel lamb data n=1825

	Genetic (s.e)
Lwt 8 wks	0.14 (0.294)
Lwt 21 wks	-0.035 (0.163)
Muscle depth	-0.068 (0.183)
Fat depth ($\log^{10}$)	**0.273 (0.086)**

Footrot correlations with performance

Texel lamb data n=1825

	Genetic (s.e)	Phenotypic (s.e)
Lwt 8 wks	0.14 (0.294)	0.022 (0.042)
Lwt 21 wks	-0.035 (0.163)	-0.03 (0.029)
Muscle depth	-0.068 (0.183)	-0.046 (0.028)
Fat depth (log^{10})	**0.273 (0.086)**	0.05 (0.001)

Genetic correlations with maternal traits - Data summary

- 2091 foot score records (from 1383 ewes)
  - Collected over 2 years from two SAC farms
- Production data from 13,900 ewes & 18,151 lambs
- Pedigree Information for 21,299 animals

Genetic correlations with maternal traits*

– Pre-mating liveweight (0.17) ☹,
– fleece weight (0.34*) ☺ or ☹
– Longevity (-0.11) ☺
– No. lambs lost to weaning (0.12) ☺
– No. lambs reared (-0.57) ☺ ☺

*McLaren et al., 2008 Proceedings British Soc Anim. Sci.

Conclusions (1)

- In general, breeding for resistance to footrot is not antagonistic to other breeding goals
  - ⇒ Although estimates of r_g are imprecise
- Footrot resistance is heritable
  - NOT heritable in 'immature' lambs?

Conclusions (2)

- Repeatability low
  - More than one scoring occasion will improve efficiency of selection
- Method of analysis matters
- Prevalence affects heritability
  - Biologically higher in high prevalence flocks

⇒ Best opportunities in high prevalence flocks

Finally…

- Selection to improve footrot in sheep is likely to bring both economic and animal welfare benefits
- Future - use of gene marker tests and GWS for resistance to footrot
  - Results of gene marker validation will be known later this year

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