How can we assess genetic resilience in our sheep flocks?




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Sheep Breeder's Round Table - 2019

Leading the way in Agriculture and Rural Research, Education and Consulting

Resilience

- *"…the capacity of the animal to be minimally affected by disturbances/challenges or to rapidly return to the state pertained before exposure to a disturbance"*

Berghof *et al.* 2019

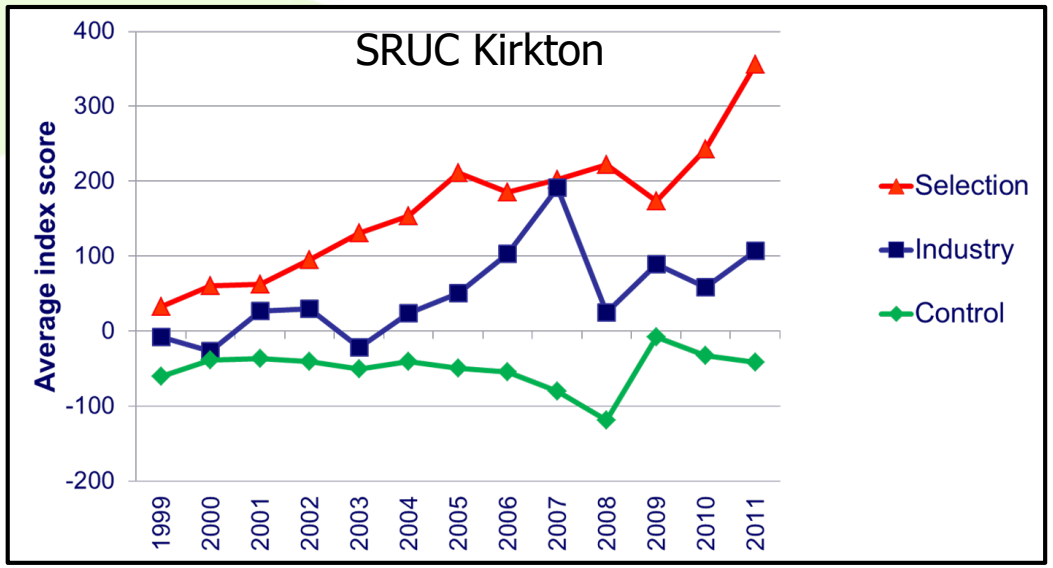
- Relevance to sheep (resilience & sustainability)
  - Variable weather conditions
  - Longevity
  - Disease
  - Different environments
  - …

SRUC's Scottish Blackface flocks

- Background
- Castlelaw Farm & Kirkton Farm
- Hill sheep breeding project (1999 – 2011)

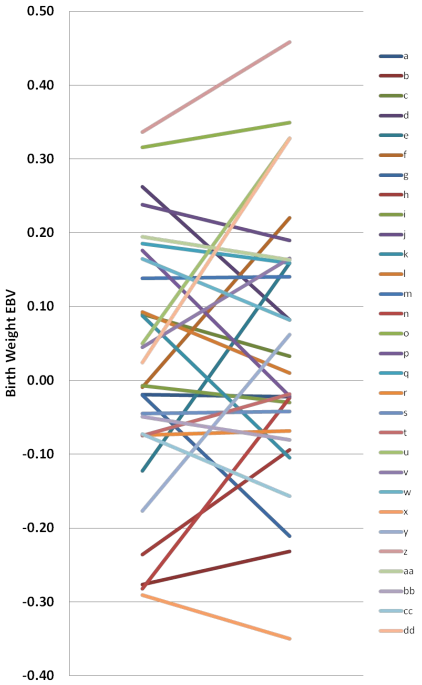
SRUC Hill Sheep Index – Scottish Blackface
Breeding goal traits

Ewe Traits	Lamb Traits
mature size	weaning weight
longevity	carcass fat class
lambs lost	carcass conformation
lambs reared	carcass weight
maternal wean weight	
fleece weight	



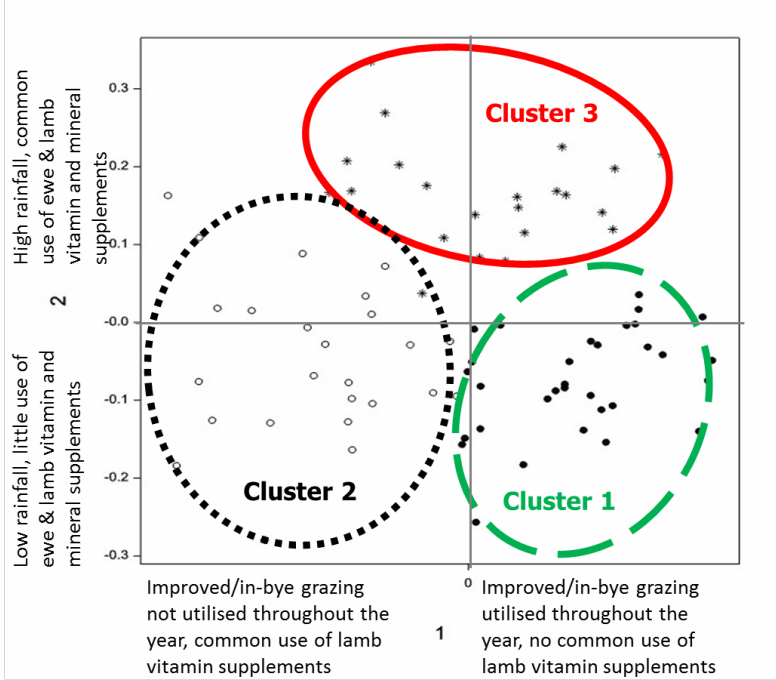
Early work – Scottish Blackface flocks

- Genotype x Environment interactions
  - Assessed by estimating genetic correlations between farms (environments)
  - Low genetic correlation = GxE
- Between 1997 – 2010
  - 30 rams with offspring on both farms
- Little GxE observed
  - GxE seen for lamb birth weight & ewe pre-mating weight
  - Little GxE seen for other traits possibly due to
    - Common sires used resilient across both environments?
    - Farm management too similar?
    - More data required?



Early work – Terminal Sire flocks

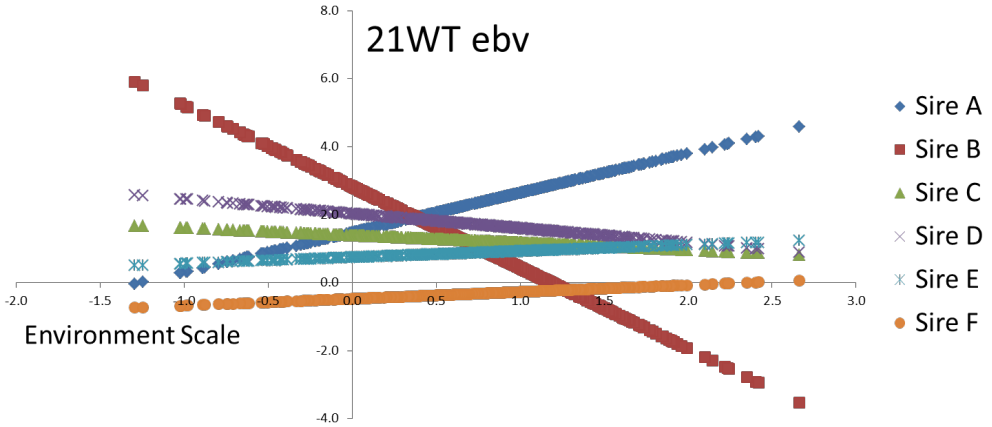
- Different definitions of environments investigated
  - Clustering similar farm types
- Data from 79 terminal sire flocks
  - 40 Texel, 21 Charollais and 18 Suffolk
- Traits investigated
  - 21 week old weight
  - Ultrasound fat and muscle depths

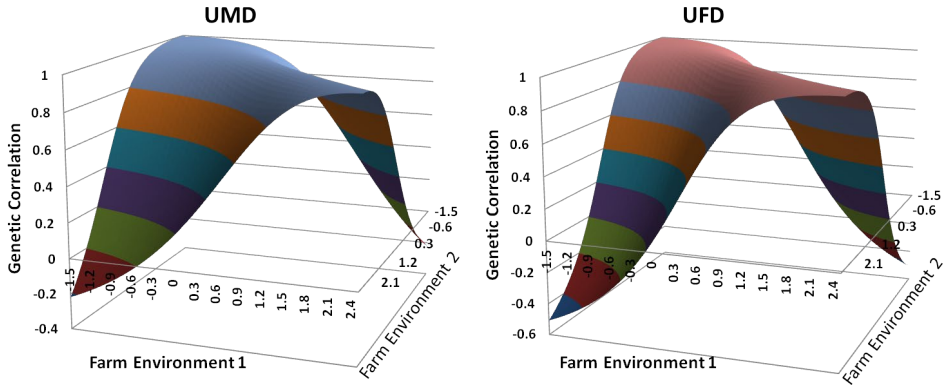


- Correlations between cluster 1 and 2 all significantly below 1 = GxE
- Evidence of sires re-ranking

Early work – Terminal Sire flocks

- Different definitions of environments investigated
  - Environmental scales
- Data from 40 Texel flocks
  - Scale based on performance and climate
  - Scaling and re-ranking of sires observed
  - Genetic correlations higher the more similar the farm environment
- Overall – evidence of GxE but difficult to identify suitable definitions of environment
  - (Flocks –v- Clusters –v- Scales)

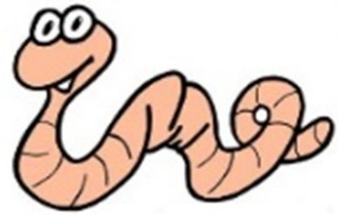




SRUC's Scottish Blackface flocks

- Background
- Castlelaw Farm & Kirkton Farm
- Hill sheep breeding project (1999 – 2011)

- From 2012



- Castlelaw – Genetic resilience relating to worms

- Kirkton – Genetic/breed resilience relating to different management systems.

Disease traits (2012 -)

- SRUC's Scottish Blackface flock – Castlelaw Farm

- Objectives
  - Estimate genetic parameters of disease traits
    - Faecal Egg Counts (FEC), DAG scores, Immunological traits
  - Assess relationship with productivity (e.g. live weight)
  - Assess genetic relationship between disease traits and immune function

Methodology

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- Data collected from 3,951 lambs
- Lambs faecal sampled at approximately 3 months of age
- Live weight and DAG score recorded at the time of faecal sampling
- DAG score = standard method of measurement used in many countries

Traits	
FEC_S	FEC Strongyles
FEC_N	FEC Nematodirus
FEC_C	FEC Coccidia
LWT	Live weight
DAG	Faecal soiling (Dag) score

Heritabilities

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Trait	FEC_S	FEC_N	FEC_C	LWT	DAG
FEC_S	0.14 (0.03)				
FEC_N		0.17 (0.03)			
FEC_C			0.09 (0.03)		
LWT				0.33 (0.05)	
DAG					0.09 (0.03)

Genetic correlations

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Trait	FEC_S	FEC_N	FEC_C	LWT	DAG
FEC_S	0.14 (0.03)	**0.74 (0.09)**	**0.39 (0.15)**	-0.01 (0.13)	0.08 (0.18)
FEC_N		0.17 (0.03)	0.23 (0.16)	-0.08 (0.12)	0.02 (0.18)
FEC_C			0.09 (0.03)	0.25 (0.15)	0.03 (0.21)
LWT				0.33 (0.05)	**-0.33 (0.15)**
DAG					0.09 (0.03)

- FEC_S and FEC_N highly linked genetically
  - (FEC_S and FEC_C also linked, but to a lesser extent)
- No significant relationship between any FEC traits and LWT or DAG
- Negative relationship between LWT and DAG – LWT reduced the higher the DAG score (i.e. dirtier)

Genetic line for reducing FEC (2012 -)

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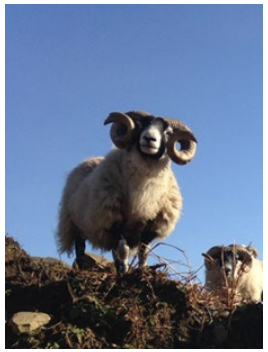
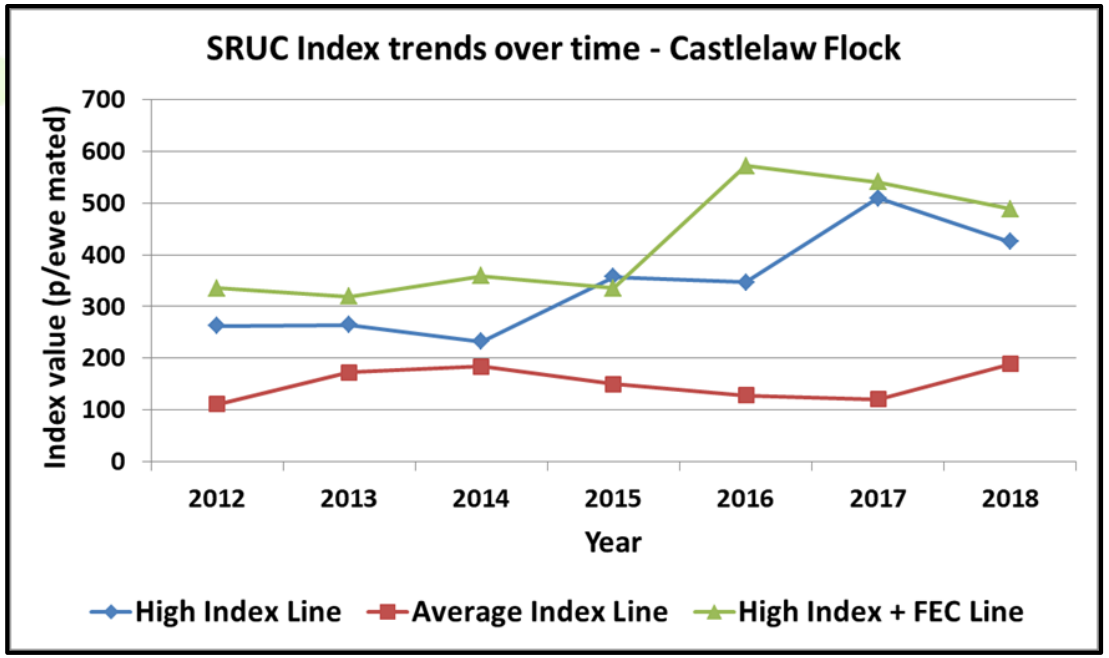
- Selection – high EBV Blackface
- Control – average EBV Blackface
- Faecal – high EBV plus FEC Blackface



SRUC Hill Sheep Index – Scottish Blackface
Breeding goal traits

Ewe Traits	Lamb Traits
mature size	weaning weight
longevity	carcass fat class
lambs lost	carcass conformation
lambs reared	carcass weight
maternal wean weight	**FEC**
fleece weight	

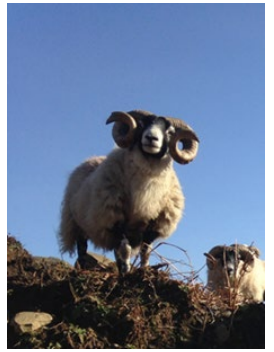


FEC conclusions

- Selection for reduced FEC is working
- Genetic correlations between different parasites are favourable
  - meaning that genetic selection for low FECs is possible, and will not affect productivity.
- Selection for FECs also confers some resistance to others (e.g. Coccidia)
- Some links have been seen in terms of immunological traits

Scottish Blackface –vs- Lleyn

- Background
- SRUC Kirkton Farm
- Hill sheep breeding project (1999 – 2011)



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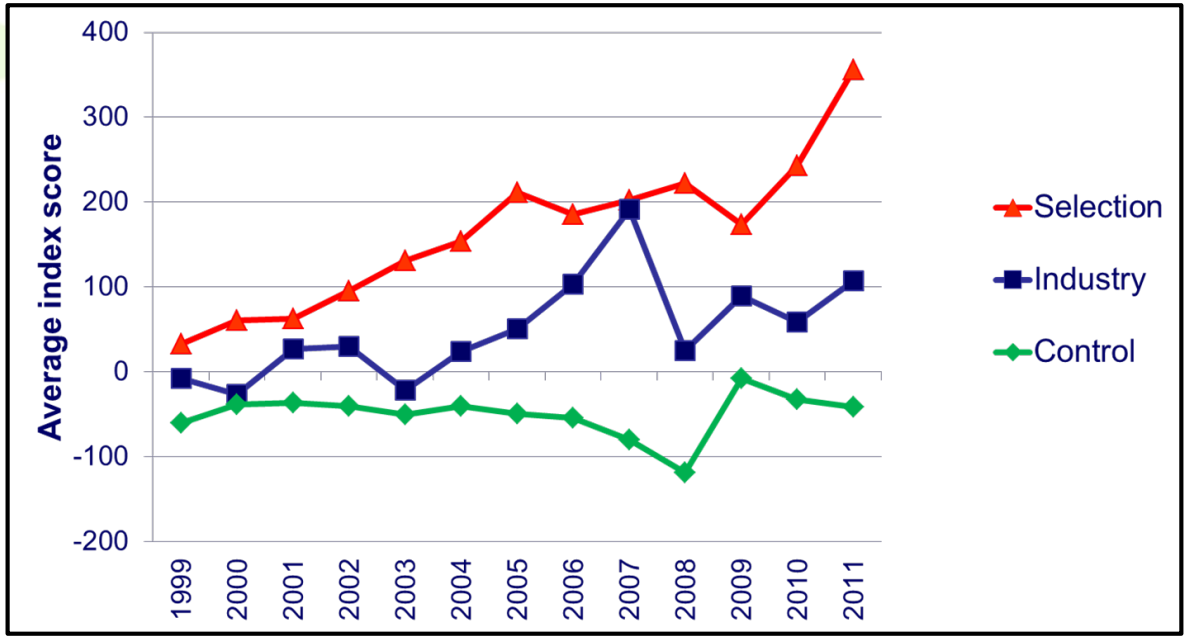


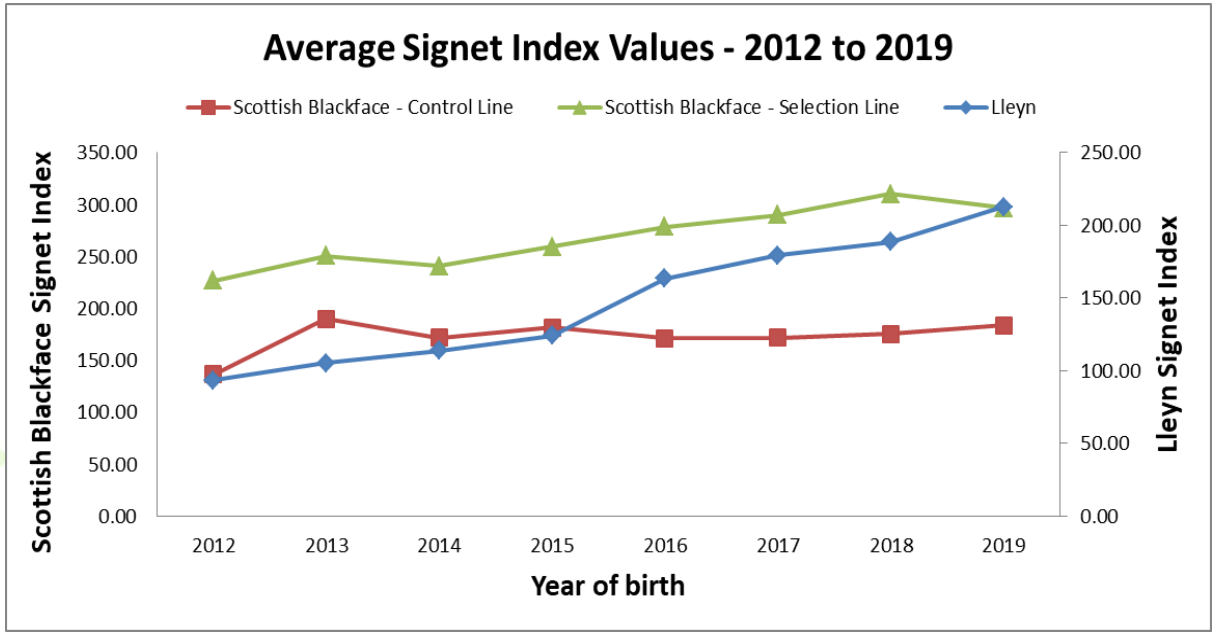
Alternative/additional breeds?

- Lleyn sheep
  - Introduced at Hill & Mountain Research Centre in 2006
  - Managed alongside Kirkton Blackface ewes since 2013

- Comparison = 3 Lines (2012 –)
  - Selection – high EBV Blackface
  - Control – average EBV Blackface
  - Lleyn – selected on EBV

Signet Indexes – Hill2 & Lleyn

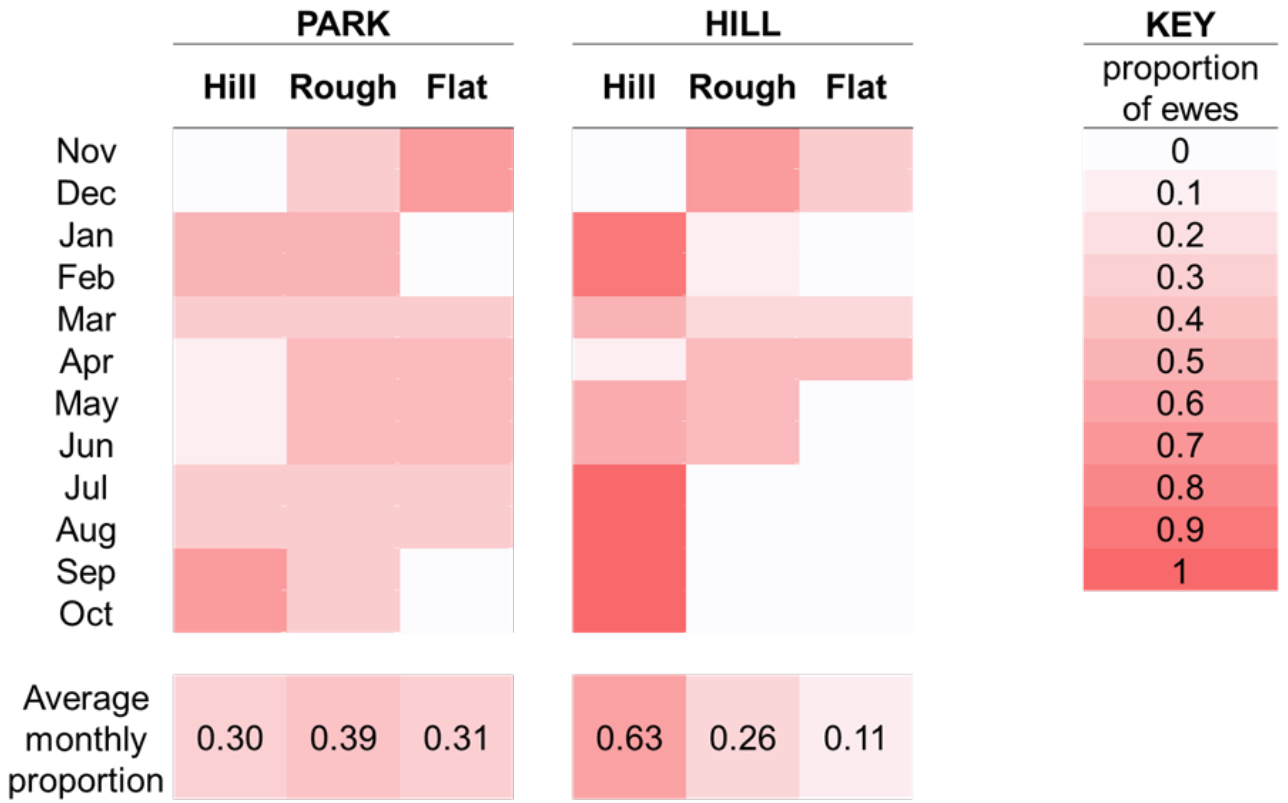
- From 2012 - Moved to selecting animals according to Signet indexes
- Also considered different management systems.
- Most recent comparison:
  - "Hill –v- Park"
  - Based on amount of time spent grazing on different quality grazing types



Hill –vs- Park Management Systems

- From 2016
- Three lines split across two different management systems.

	Selection	Control	Lleyn
Hill	100	100	100
Park	100	100	100



Hill –vs- Park Management Systems - Ewes

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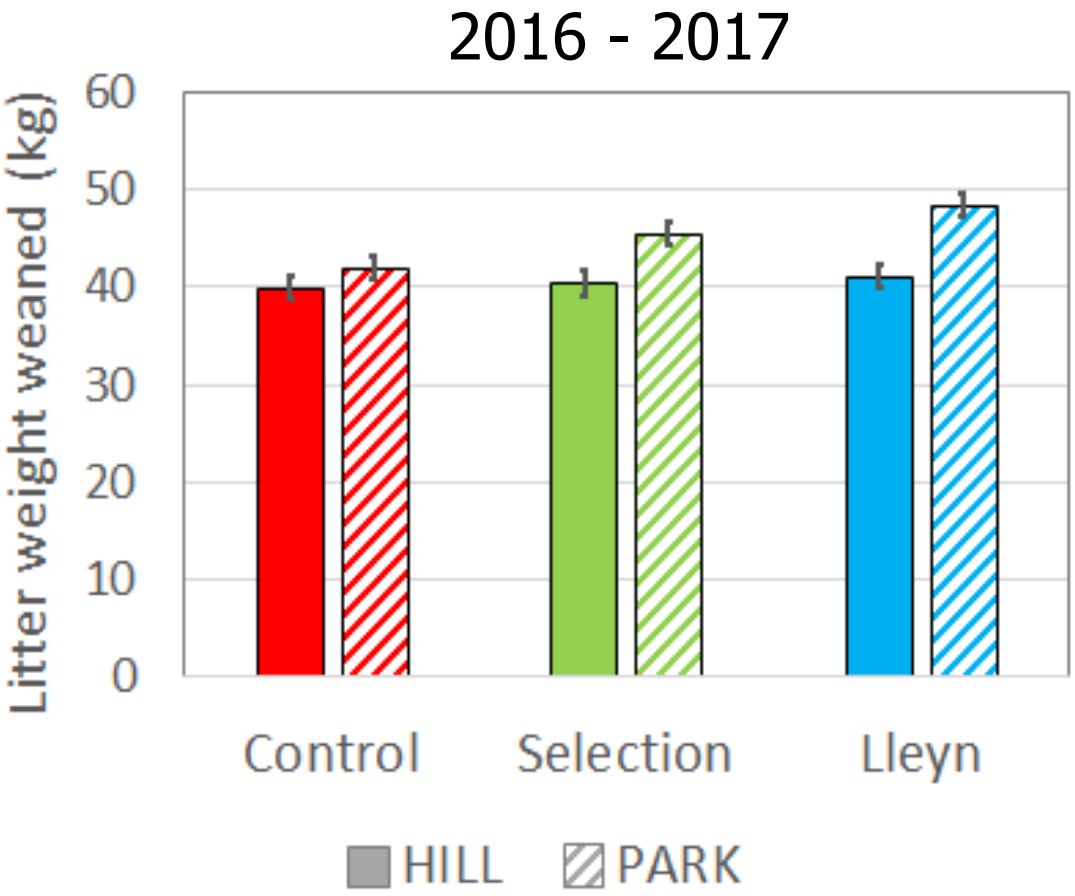
- Litter size
  - No significant line x system interaction
- Litter weight weaned
  - Significant line x system interaction
    - Hill – no line differences
    - Park – Lleyns > Selection > Control
- HILL v PARK
  - Control = no difference
  - Selection = Park > Hill
  - Lleyn = Park > Hill



Hill –vs- Park Management Systems - Ewes

- But…
  - Extreme weather e.g. “Beast from the East”
  - Too much for the Lleyns?

2018

	PARK			HILL	
	SBF	Lleyn		SBF	Lleyn
Scanning %	134	114		129	96
Lambing % (born dead or alive)	131	101		122	90
Lambing % (born alive)	126	98		115	85
Marking %	113	86		103	63
Ewes aborted (% of ewes scanned in lamb)	7	18		11	9
Lambs born dead (% of all born)	4	3		4	6
Lambs lost from scanning to marking %	16	25		20	34
Lambs lost from birth to marking %	12	14		12	35

N.B. Average scan % in 2016 and 2017 = 131% in SBF; 136% Lleyn

Hill –vs- Park Management Systems - Lambs

- Lamb growth
  - Roughly equal number from
    - Hill & Park
    - Selection, Control and Lleyn

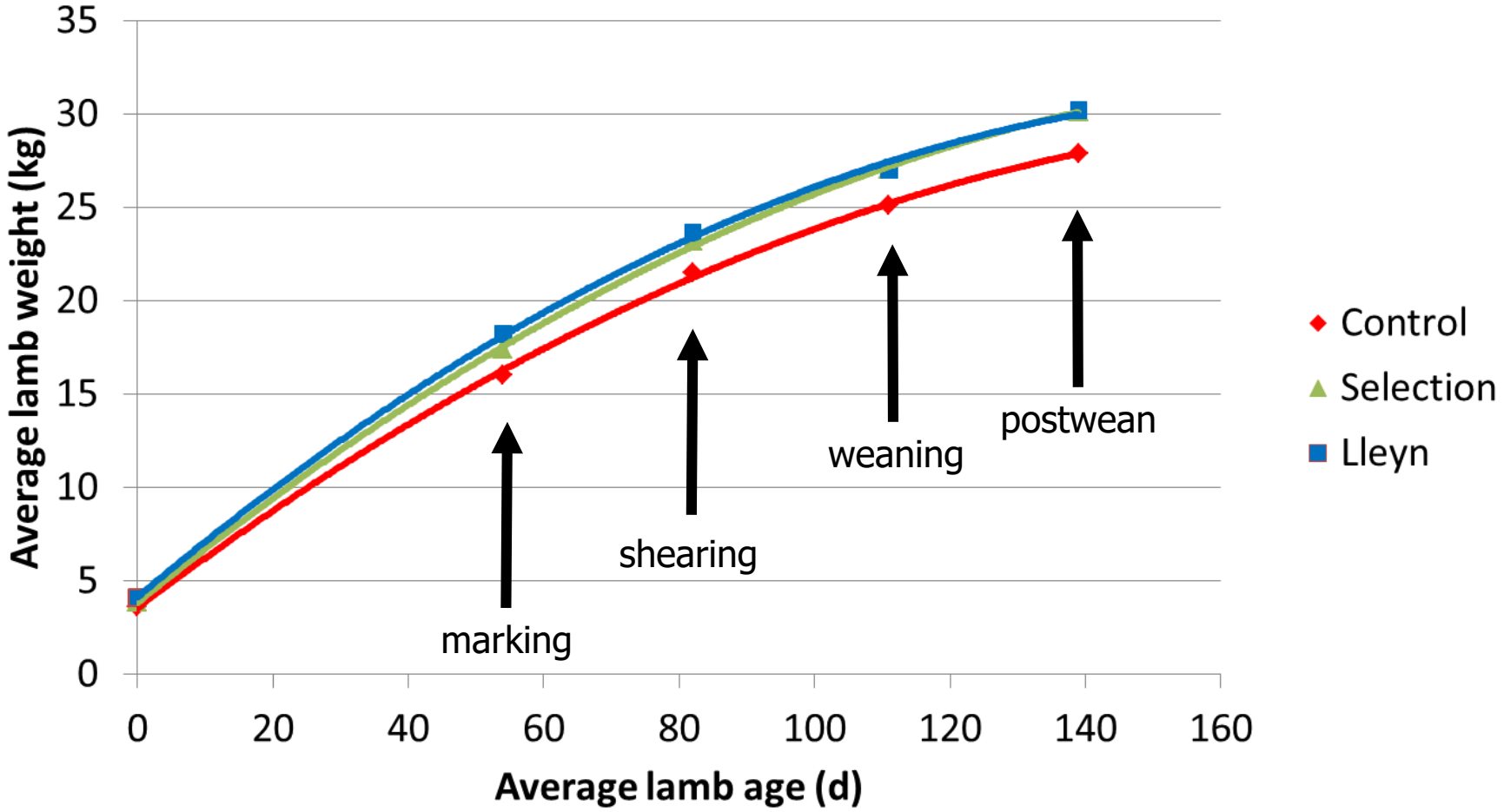
	Average age (d)	Total no. records
birth	0	1228
marking	54	1088
clipping	82	1052
weaning	111	1062
post-wean	139	1035

	PARK System			HILL System		
	Hill	Rough Fields	Flat Fields	Hill	Rough Fields	Flat Fields
lambing		Singles and twins			Singles and twins	
post-Lamb – marking		Singles and twins		Singles	Twins	
marking – weaning	Single females	Single males and twins		Singles & twins		
post-wean: ewe lambs		All			All	
post-wean: tup lambs	Grazing flat fields with hoppers - slaughter			Finished in shed - slaughter		

Averaged across systems (2016 & 2017)

Holly Smith, BSc Hons dissertation, 2019

- Birth & marking
  - Lleyn > Selection > Control
- Shearing to postwean
  - Lleyn & Selection > Control

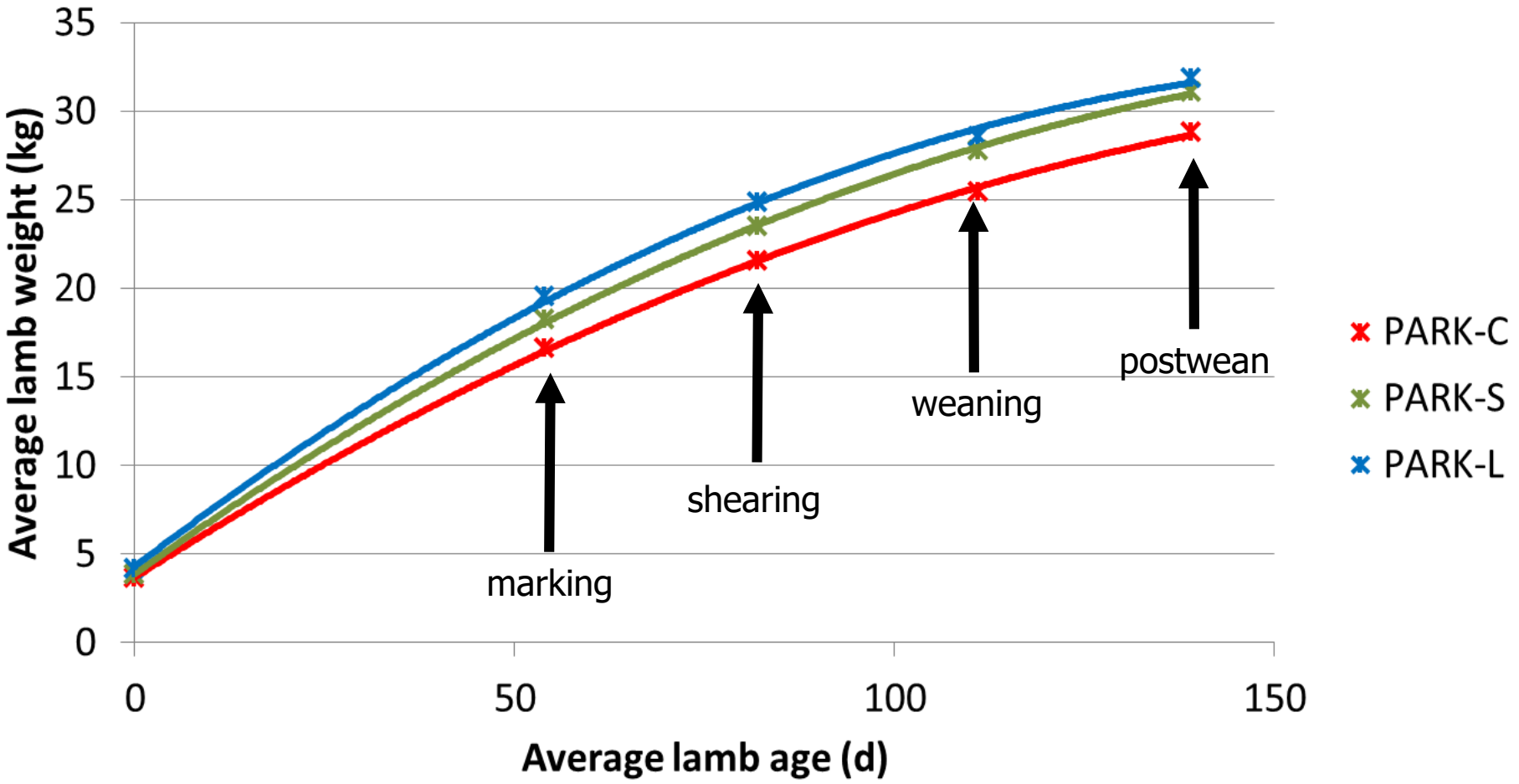


Line x System – PARK (2016 & 2017)

Holly Smith, BSc Hons dissertation, 2019

- Birth to weaning
  - Lleyn > Selection > Control
- Postwean
  - Lleyn & Selection > Control

(♂ grass + concentrates)

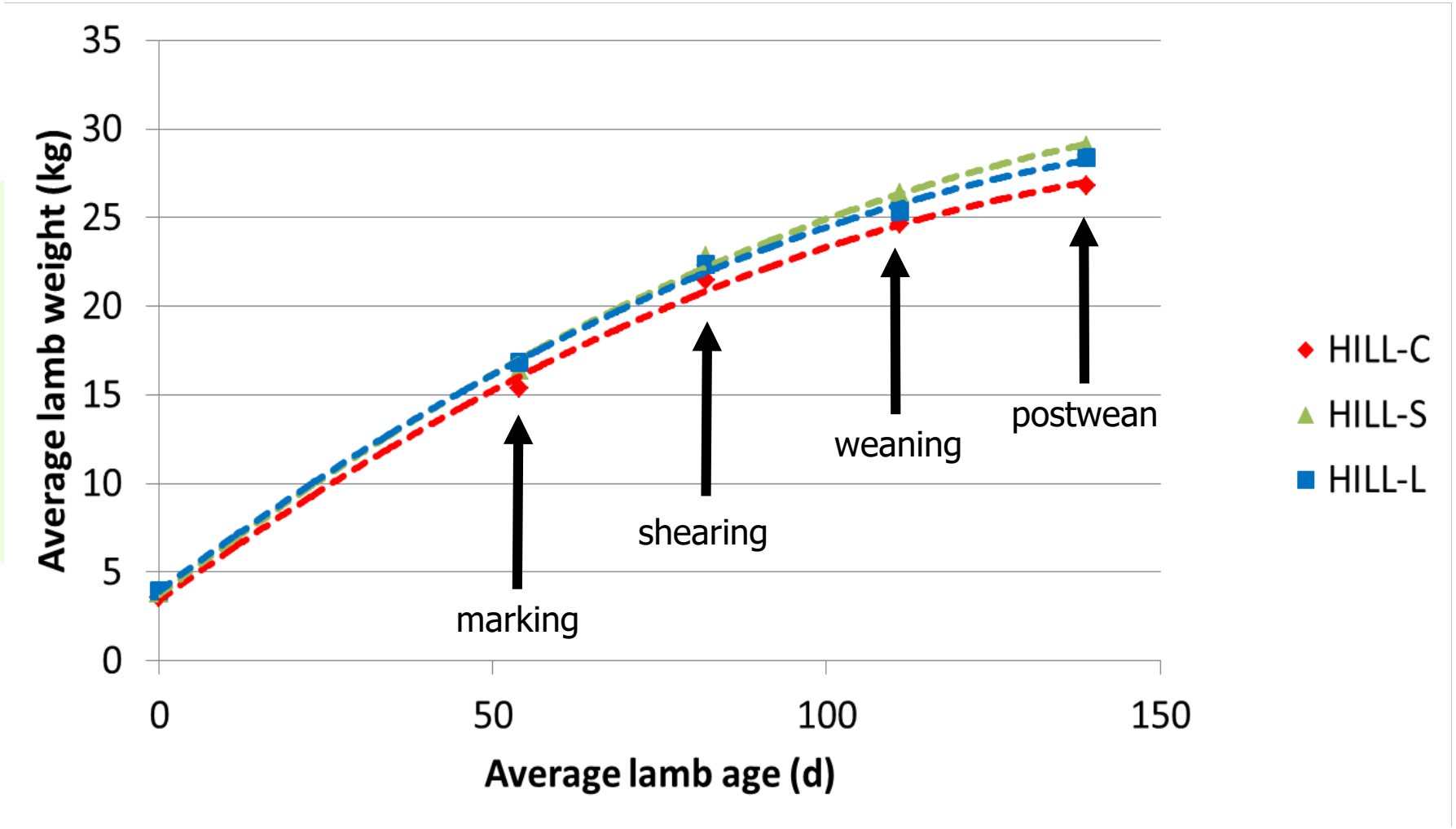


Line x System – HILL (2016 & 2017)

Holly Smith, BSc Hons dissertation, 2019

- Birth to shearing
  - Lleyn & Selection > Control
- Weaning
  - Selection > Lleyn & Control
- Postwean
  - Lleyn & Selection > Control

(♂ concentrates in shed)



Systems conclusions

- Breed improvement has increased performance of Scottish blackface hill sheep
- Breed substitution using Lleyn sheep could match or increase performance
- Benefits may depend on hill system and climate
  - Lleyns successful until pushed too far?
- Further work to look at reasons for differences
  - Feed intake, grazing behaviour, colostrum quality, welfare assessments, lamb mortality…
  - Genetic influences

Acknowledgements

- Commercial farmers involved in data collection
- All SRUC technical and farm staff involved in data collection

iSAGE Innovation for Sustainable Sheep and Goat Production in Europe

Scottish Government
Riaghaltas na h-Alba
gov.scot

Moredun Research Institute

Signet BREEDING SERVICES

AHDB BEEF & LAMB

HYBU CIG CYMRU MEAT PROMOTION WALES

QMS QUALITY MEAT SCOTLAND

GENES

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