Genetic approaches to improving lamb survival under extensive field conditions

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beef+lamb new zealand GENETICS

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Introduction

Poor lamb survival is key cause of reproductive inefficiency in flocks globally

- Published reports of lamb survival average 85% over 40 years, with no detectable improvement over that period (*Dwyer et al. 2016* ***Animal*** **10:** 449)

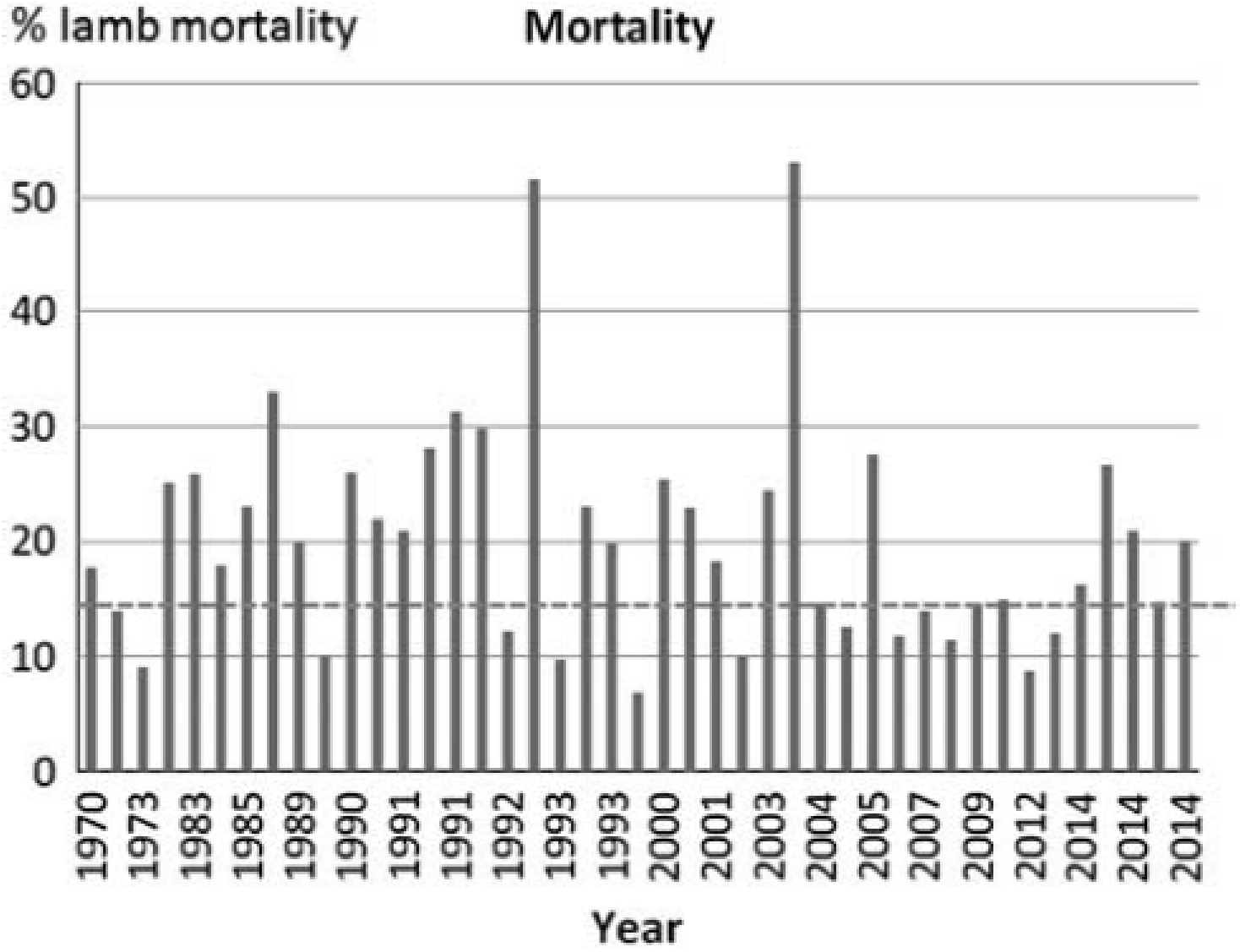


Figure 1. Published average percentage lamb mortality between 1970 and 2014 showing no improvement over 40 years. The dotted line represents an overall average mortality of 15%. (After Dwyer *et al.* 2016)

Introduction

Poor lamb survival is a key cause of reproductive inefficiency in flocks around the world

- Published reports of lamb survival average 85% over 40 years, with no detectable improvement over that period (Dwyer *et al.* 2016)
- Growing welfare issue as well as a significant economic loss
- In Australia, lamb loss estimated cost is $540 Million AUD/year (Meat & Livestock Australia 2015), about 8% of total farm gate value of the sheep industry
- This presentation discusses genetic approaches to improving lamb survival under extensive conditions

Lamb survival under extensive conditions

- In Australia, New Zealand & South Africa, lamb survival estimated at 75-81%, based of pregnancy scanning in many flocks (especially in Merinos)

- Lower survival in twin-born lambs (56-71%). Survival of multiple-born lambs is often less, but few are born compared with prolific breeds

Ewe condition score at lambing & lamb survival

Results: 13 Australian farms (Behrendt et al. 2011 Anim.Prod.Sci. 51: 805)

Ewe nutrition during pregnancy	Condition Score at Lambing	Parity	Lamb Survival (%)	
Low	2.3	Single bearing	85	+6
High	3.2	Single bearing	91	
Low	2.2	Twin bearing	57	+14
High	3.2	Twin bearing	71	

- *Lamb survival up by 6 in single & 14 % points in twin-bearing ewes, with increase of 1 condition score*
- *Even with optimal ewe nutrition, survival in twins is only 71%, whereas single survival >90%*
- *Despite optimal ewe nutrition, still considerable scope to improve survival in twins*

Improving lamb survival via selection

Challenging, but rewarding

- Slow genetic gain from low heritability/accuracy (fitness trait)
  - High variability partly compensates
  - Selection in both sexes helps – higher selection intensity, unlike net reproduction rate (ewes only)
  - Binary trait – need relatives data to discriminate b/w candidates
  - Boost accuracy in general with data on relatives & indicator traits

Relative response to direct selection

Lamb survival vs other traits

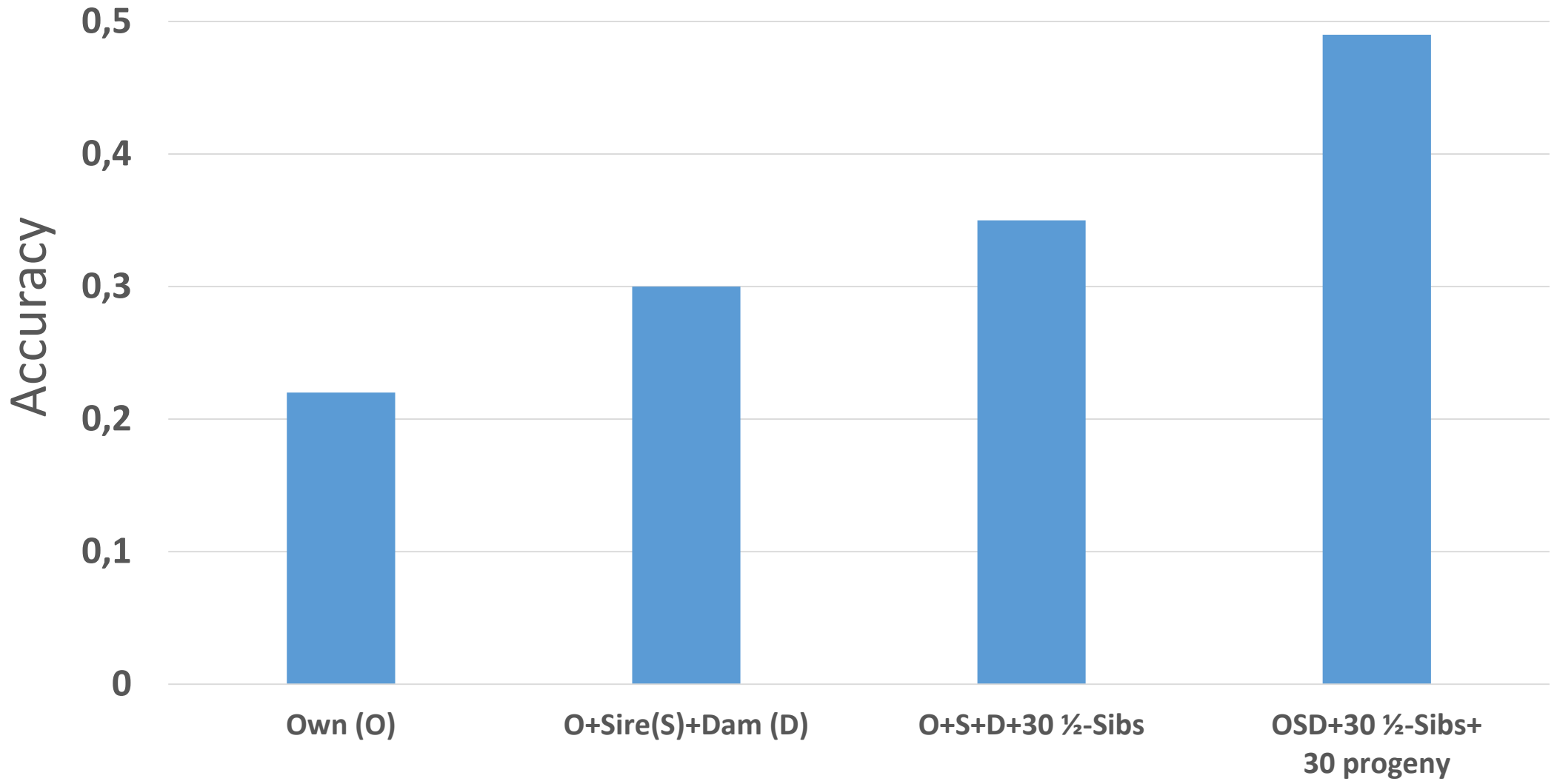
Trait	Heritability	Coefficient of Variation (%)	Relative response to direct selection
Clean fleece weight	0.42	16.3	100
Lambs born per ewe mated	0.05	63.2	50
Lamb Survival to Weaning	***0.03***	***49.4***	***14***

Brien et al.(2014). Anim.Prod.Sci. 54: 667

- *High coefficient of variation for lamb survival partly compensates for low heritability*
- *Notwithstanding, relative response to selection for lamb survival is obviously slow*

Genetic evaluation of lamb survival

Number of Relatives and Accuracy



Improving lamb survival via selection

Challenging, but rewarding

- Low rate of genetic gain from low heritability (low selection accuracy)
  - High variability & ability to select in both sexes partly compensate
  - Can lift accuracy with information from relatives & indicator traits
- Gains are permanent & cumulative
- Costs are borne in studs (2-4% of national flock), so benefit to cost ratio is likely favourable

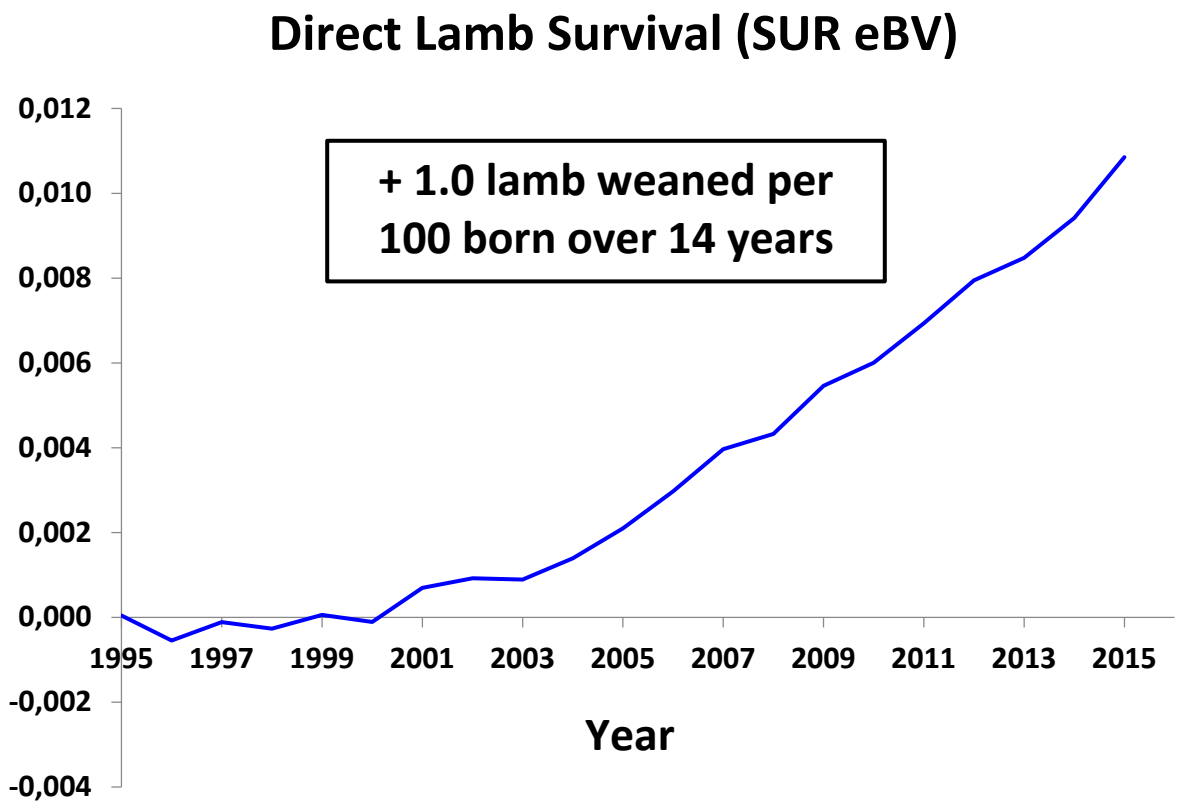
Genetic evaluation of lamb survival

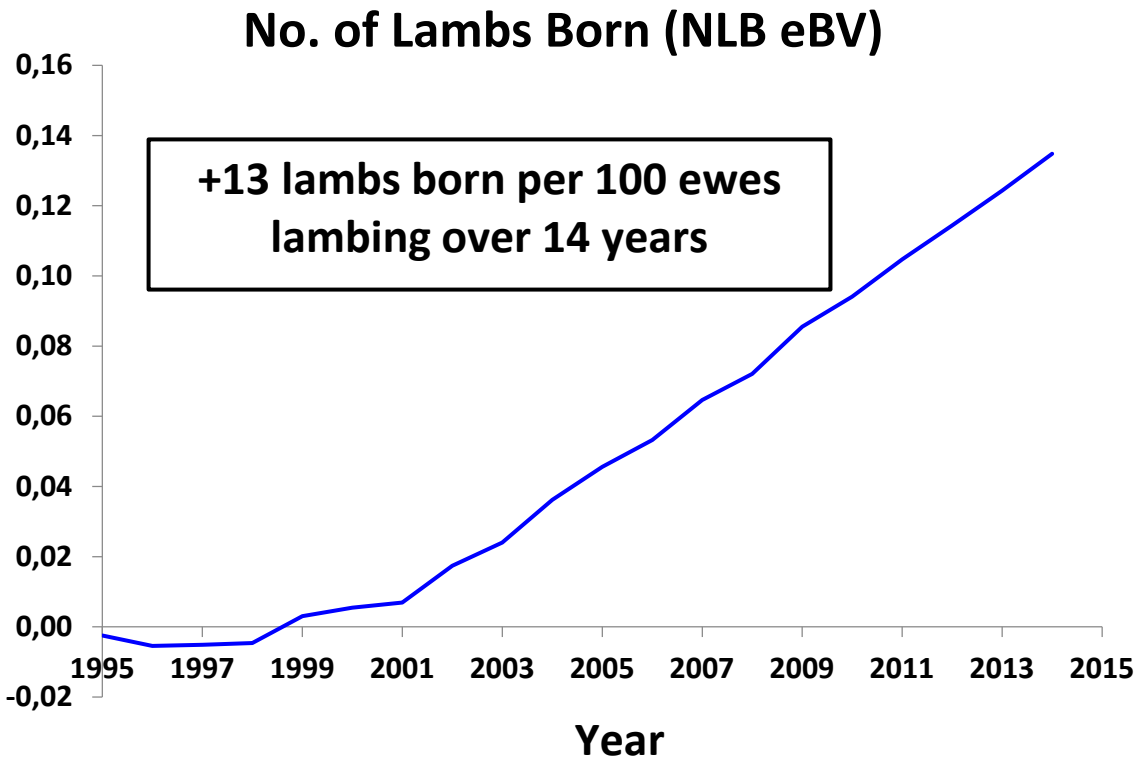
Some instances of implementation

Country	Lamb Survival Evaluated	When Commenced	Genetic Evaluation - Base trait(s)	Reference
New Zealand	Yes	2001	Lamb trait – direct & maternal	Young & McIntyre (2006). Sheep Improvement Ltd
Ireland	Yes	2009	Lamb trait – direct	Byrne *et al.* (2010). Livest. Sci. **132:** 135
United Kingdom	Yes	2016 ????	Lamb trait – direct Ewe trait – rearing ability	J. Conington (*pers. comm.*)
Australia	Starting soon	2017 2006	Ewe trait – rearing ability No. of lambs born & weaned	Bunter *et al.* (2016). Anim. Prod. Sci. (*submitted*)

Genetic trend: Lamb Survival & Litter Size

Dual purpose maternal flocks in New Zealand





Young & Newman, SIL (unpublished)

- *Small genetic increase in lamb survival under index selection*
- *Achieved against a much larger increase in litter size*

Can we improve genetic gains for lamb survival?

4 broad categories

- ❑ Improved data & pedigree recording
- ❑ Improved trait modelling
- ❑ Adding Indicator/predictor traits
- ❑ Genomic markers

Can we improve genetic gains for lamb survival?

Data & pedigree recording

- Improving the interpretation of field records of lamb survival
  - Post-weaning records to update data in NZ (Vanderick *et al.* 2015 JAS)
- Creating an inventory of reproduction records
  - Pregnancy scanning – adding foetal count, ± birth type
  - Foetal ageing as a check on birth dates (or replacement?)
- More complete pedigree records – greater accuracy
- Progeny testing of ram lambs – double gain? (Brien *et al.* 2011 AAABG)

Sheep Recording in Australia

(Brien et al. 2011 AAABG)

Breed or breed type	Active flocks	Flocks with reproduction records	%
Terminals	595	46	8%
Border Leicester	84	37	44%
Merino	205	37	18%
Coopworth	52	27	52%
TOTAL	**936**	**147**	**16%**

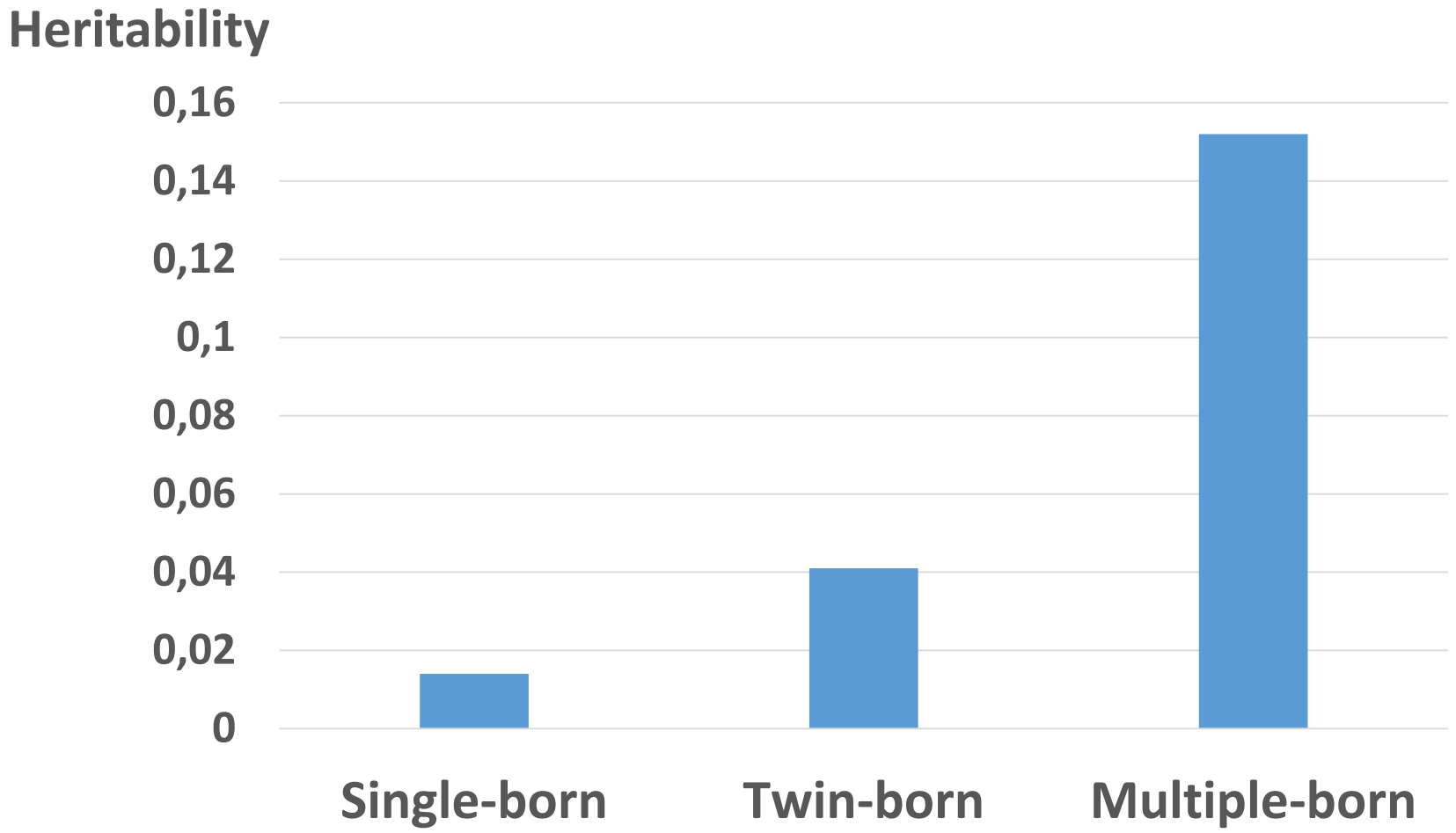
- ***Low % of flocks with sufficient pedigree to select for reproduction & lamb survival***
- ***Cost/effort to collect lambing records / pedigree is a barrier – considerable focus on DNA Testing and pedigree identity by association (Pedigree Matchmaker)***

Can we improve genetic gains for lamb survival?
Trait modelling

- Improving existing models
  - Accounting for random litter effects (Vanderick *et al.* 2015 J.Anim.Sci .93: 3765)
- Analyse by litter size
  - Heritability higher in twins/multiples than singles (Kelly *et al.* 2016, ASAP)
  - Scaling for unifying breeding values by litter size (Bunter *et al.* 2016)
- Alternative analysis (e.g. threshold models – Cloete *et al.* 2009, J.Anim.Sci 87: 2196)
- Refining ASREML to better analyse categorical traits? (A. Verbyla, *pers. comm.)*

Heritability for lamb survival

by birth type (Kelly et al. 2016, ASAP)



Can we improve genetic gains for lamb survival?

Adding Indicator/predictor traits

- ❑Lambing Ease / Lambing Difficulty / Birth Assistance
- ❑Lamb Vigour - scores
- ❑Maternal Behaviour Score & Agitation Score
- ❑Lamb Rectal Temperature
- ❑Timed lamb behaviours – latency to bleat, stand, suckle, contact & follow ewe

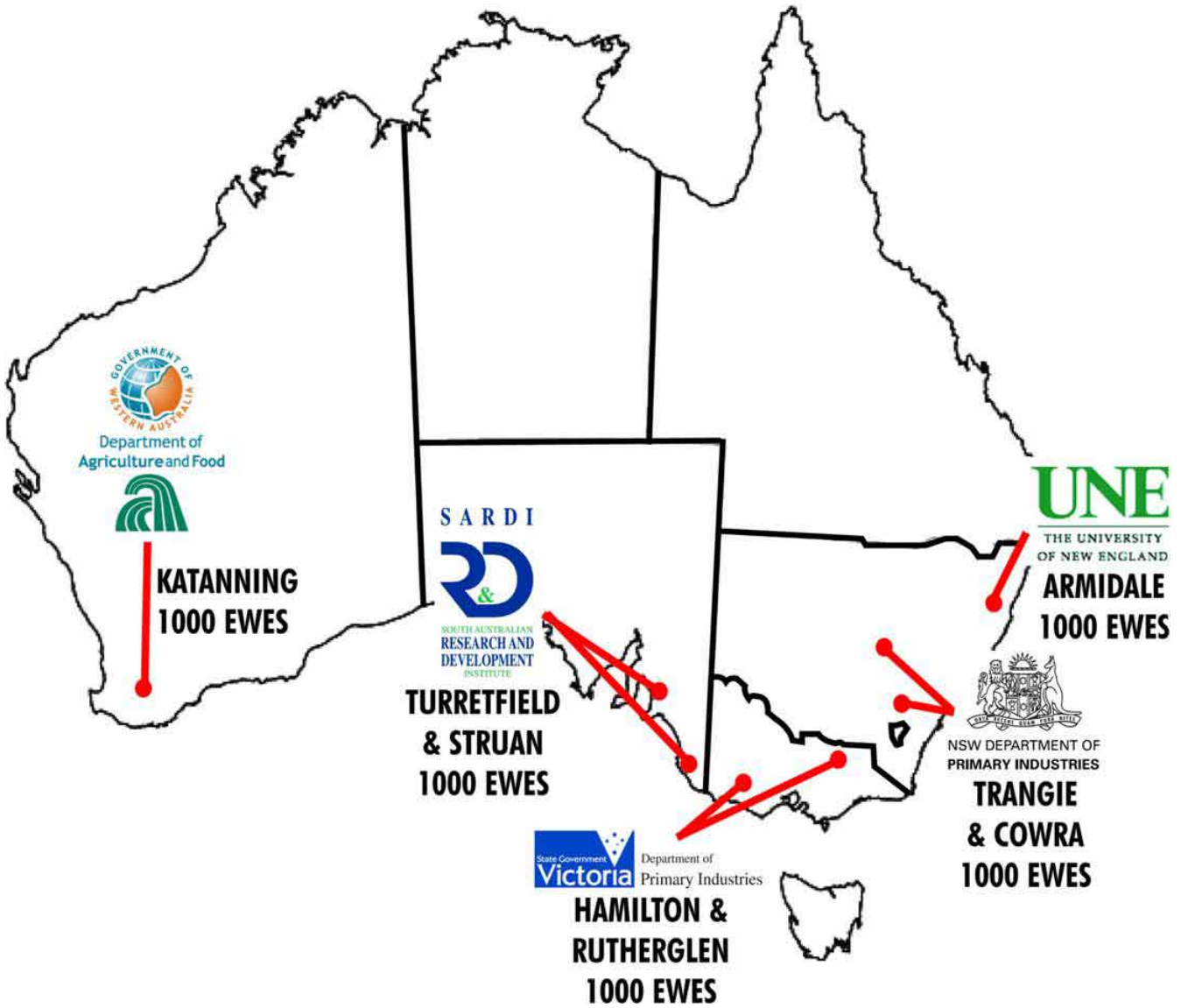
Can we improve genetic gains for lamb survival?
Genomic markers. Epigenetics?

- Difficult for traits of low heritability
  - Cold tolerance testing (Forrest *et al.* 2006, Anim.Genet. 37: 465)
  - Genomic prediction, based on SNP panel
- Reproduction Traits (Daetwyler *et al.* 2014, 10th WCGALP 156)
  - For Number of Lambs Weaned, accuracies 0.2-0.3 in young Merino males with 56K SNP chip
  - Detection of carriers for lethal recessive mutations a possibility
- Non-additive genetic variance
  - epigenetics – define size of effects. Consider in modelling of trait

CRC for Sheep Industry Innovation 2007 – 2019 (Sheep CRC)

Large team of people involved. Dr Michelle Hebart, Univ. of Adelaide did the genetic analysis work related to lamb survival for the Sheep CRC

Information Nucleus Sites: 2007-2014



Reproductive measures

Information Nucleus (2007-2014)

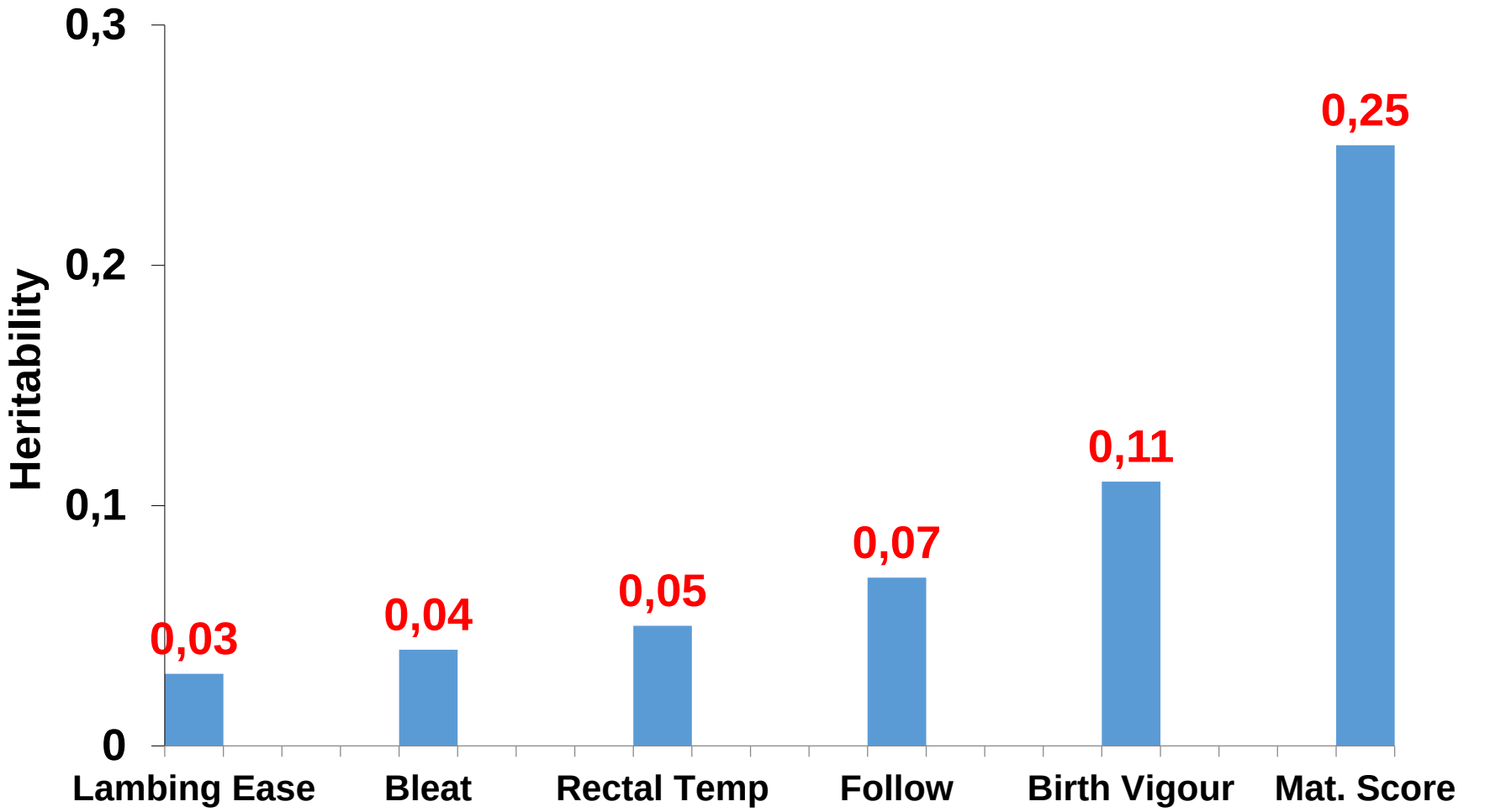
Time	Measurement/Score
Pre-Mating	Ewe live weight, Condition score (CS)
A.I. Mating	Ewe live weight, CS
Mid-Pregnancy	Foetal scan, Ewe live weight, CS
Lambing	Birth weight Birth coat score Lamb vigour Rectal temp. Lamb ease Maternal behaviour score Skeletal measurements
Death	Autopsies

Indicators of lamb survival
Scores/measurements on day of birth

- Rectal temperature
  - Strongly related genetically to survival
- Maternal behaviour, lambing ease & observed birth vigour scores
  - Promising indicators and easy to score
  - Related genetically to survival & higher heritability
- Timed lamb behaviours
  - Bleating & following behaviour also genetically linked to survival, but are timing-consuming to record

Heritability

Indicator traits for lamb survival

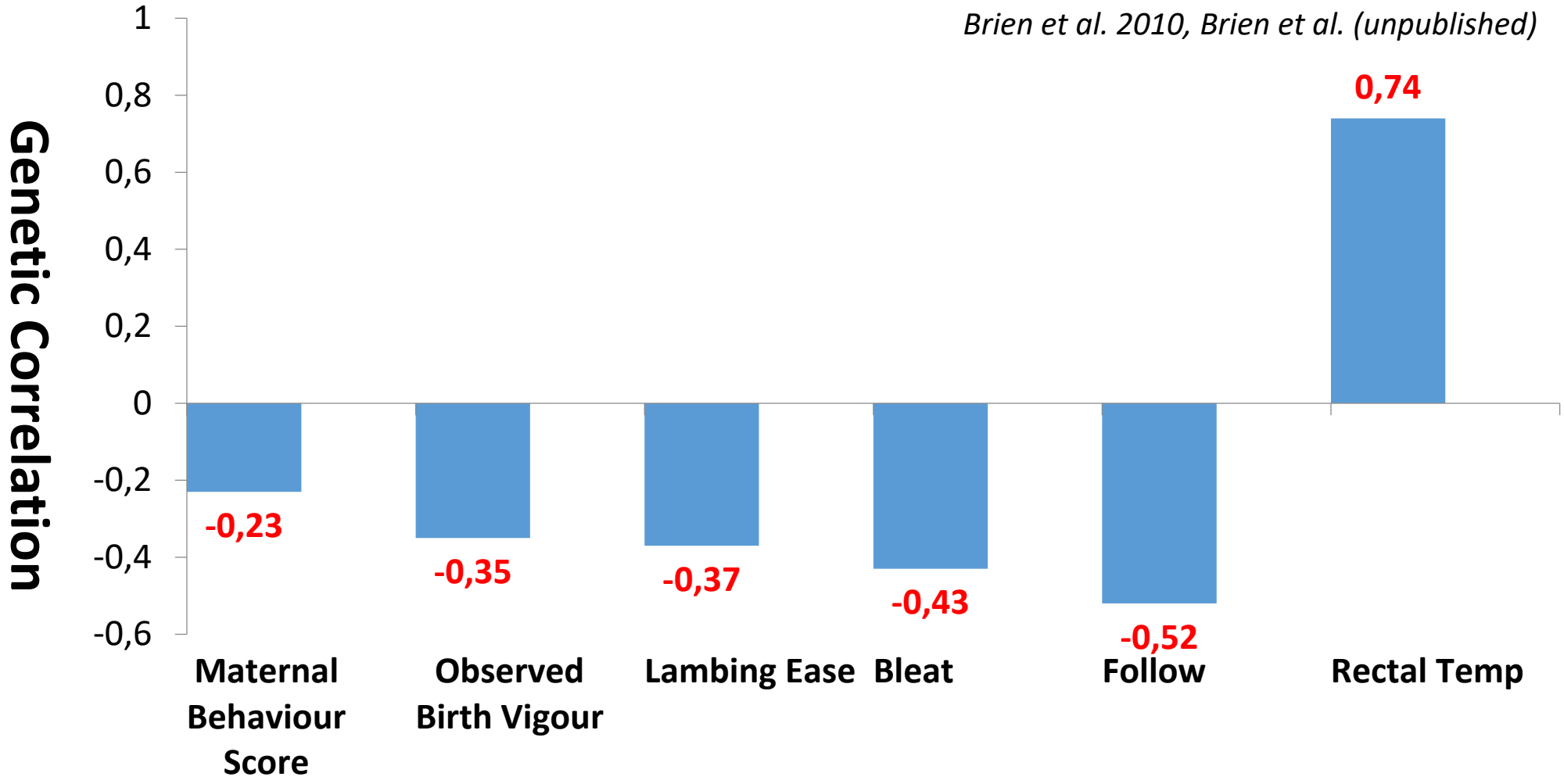


Brien et al. 2010 Anim.Prod.Sci 50: 1017; Brien et al. (unpublished)

Genetic Correlations

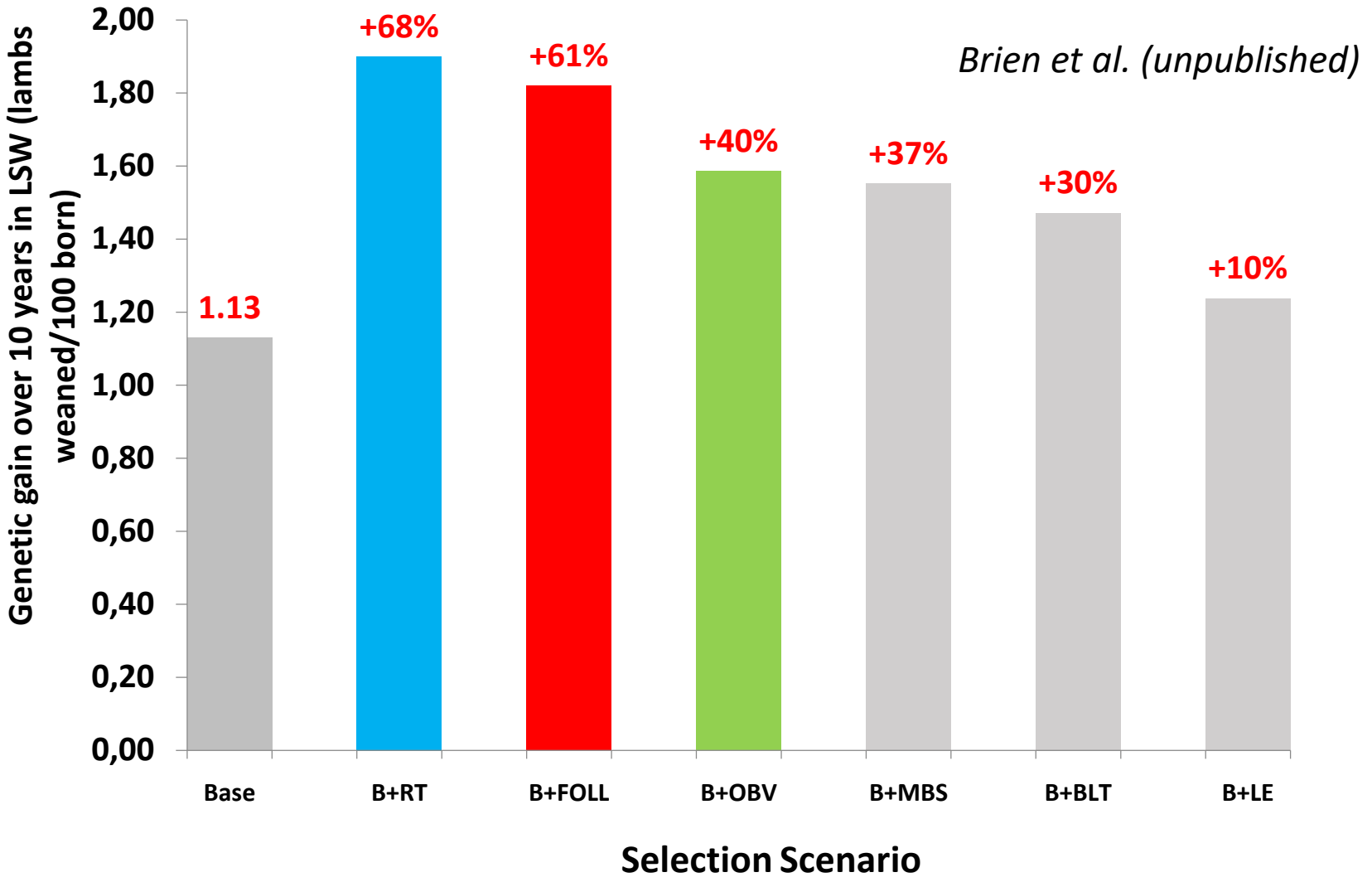
Indicator traits vs lamb survival to weaning

Brien et al. 2010, Brien et al. (unpublished)



Predicted genetic gain in lamb survival

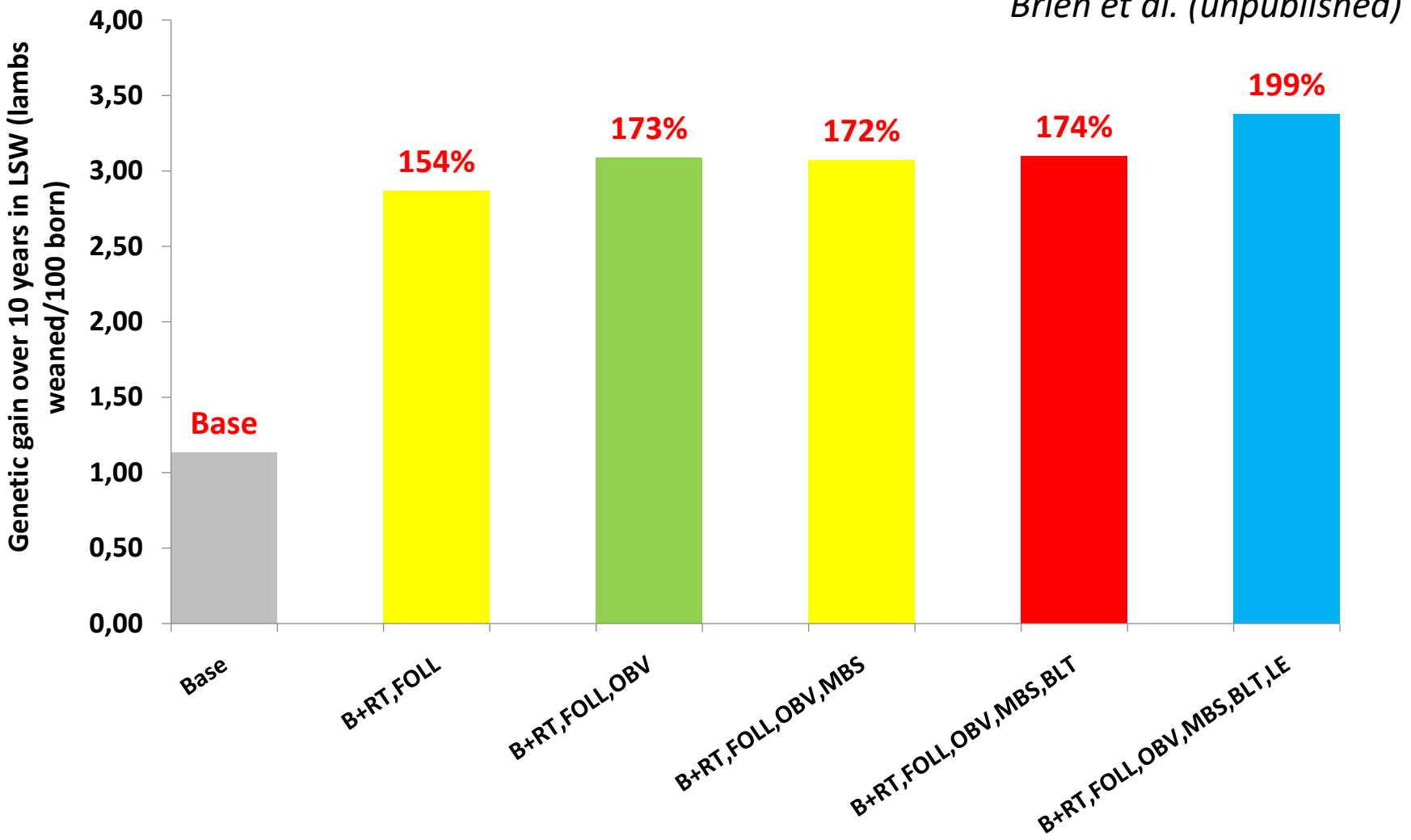
Adding criteria individually to a base DP+ index



Predicted genetic gain in lamb survival

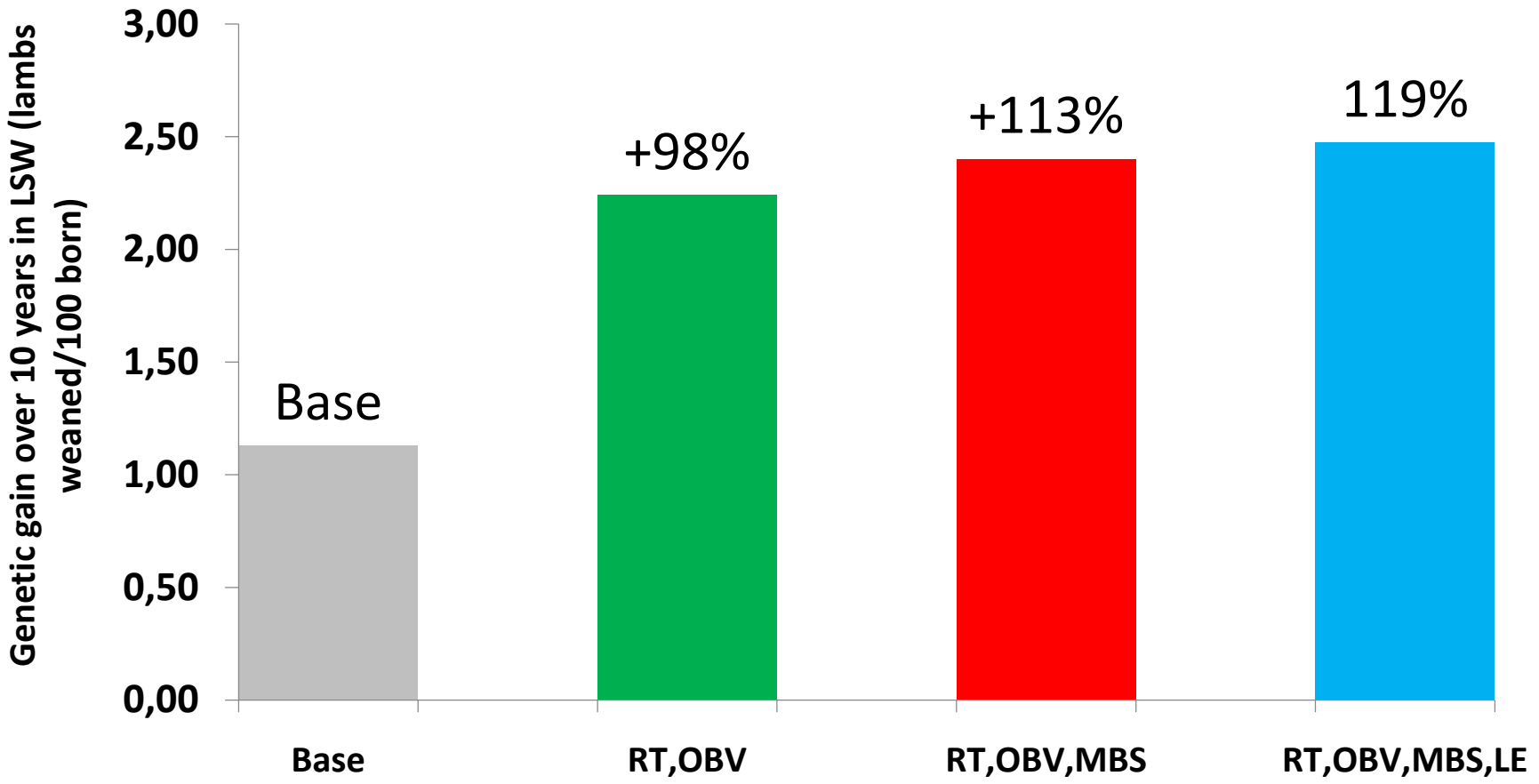
Adding criteria in combinations to base index

Brien et al. (unpublished)



Predicted genetic gain in lamb survival

Adding criteria in combinations to base – most practical ones



Brien et al. (unpublished)

Conclusions

- Achieving genetic gain in lamb survival is challenging, but incremental gains can be had. This complements improvements in management – *nutrition, shelter*

- Soon, several countries will have lamb survival in their national evaluations

- Gains of +1.0 lambs weaned/100 born ***i.e. survival*** & +13 lambs born/100 ewes lambing ***i.e. litter size*** have been achieved over 14 years in New Zealand, under index selection

- Potential ways of boosting rate of genetic gain, include:
  - *Improved data recording – lamb deaths and pedigree*
  - *Better genetic models fitted in evaluations*
  - *Use of indicator traits to lift accuracy. Genomics?*

11th WORLD CONGRESS ON GENETICS APPLIED TO LIVESTOCK PRODUCTION

11–16 February 2018
Aotea Centre
Auckland
New Zealand

wcgalp.com

How a genetic approach to improve lamb survival can suit extensively-run flocks

- Focus on preparation before lambing
  - *Optimise ewe nutrition, health (vaccinations & anthelmintics)*
  - *Provide adequate pasture and shelter for lambing*
  - *Manage ewes in litter size classes? Optimise flock size & density*

- Management during lambing
  - *Non-recorded flocks, little intervention, less mismothering, low labour costs*
  - *In studs, need pedigree: lambing rounds, Pedigree Matchmaker or DNA test*
  - *Optional recording of indicator traits close to birth to boost accuracy*
  - *Need easy/quick to measure traits*