Innovation in Valuing and Breeding for Eating Quality in Lamb

Daniel Brown, Peta Bradley, Sarita Guy, Sue Mortimer, Liz Pannier, Peter McGilchrist, David Pethick, Andrew Swan, Graham Gardner

The Issue

Lamb has historically been a commodity product but this is no longer acceptable

Genetic decline in EQ but consumers expect high quality eating experience

The Solution

An integrated RD&E program to deliver better phenotypic and genetic description of both LMY and EQ throughout the whole value chain

agbu

Outline

1. Lean meat yield and eating quality in lamb
2. Simultaneous genetic improvement for LMY and EQ
3. Industry wide approach

MEAT & LIVESTOCK AUSTRALIA

1. LMY and EQ in lamb

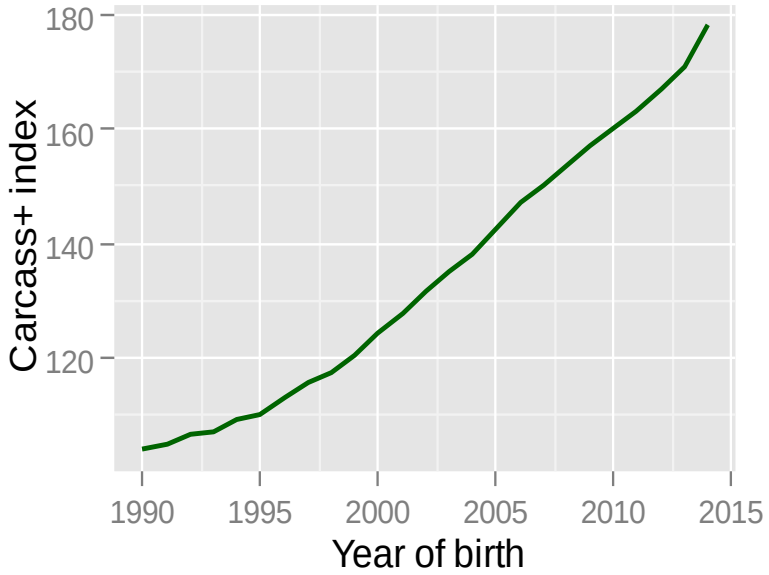
1) Data and knowledge generation

2) Understanding consumer expectations

MEAT & LIVESTOCK AUSTRALIA

Breeding directions for meat sheep

- Long term gains in growth rate and lean meat yield



Carcass+ = simple breeding objective, accurately assessed

- To remain competitive the industry also needs to address meat quality:
  - Selection for growth and lean → decreased eating quality

Transition from a commodity product

Source: Lambpro

Resource Flocks in Australia

- 2005 – 2023
  - Sheep CRC - MLA
- Multiple sites across Australia
- 100 sires mated annually
  - Merino
  - Terminal
  - Maternal
- Comprehensive phenotyping of progeny
- SNP genotypes (15K, 50K, HD, Seq)

agbu

Australian sheep reference population

Traits

Composition

- **CT Lean meat yield (%)**
  n ~ 3,500
- **Carcase eye muscle depth (mm)**
  n ~ 40,000

Objective Eating Quality

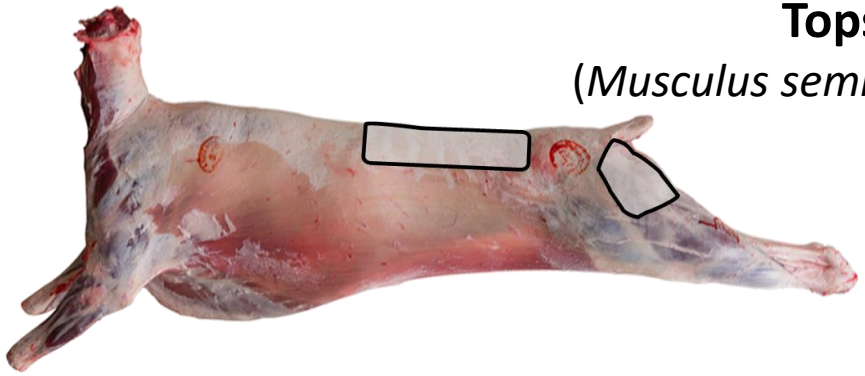
- **Intramuscular fat (%)**
  n ~ 36,100
- **Shear force (N)**
  n ~ 37,200

Consumer eating quality (0 to 100)

- **Tenderness**
- **Flavour**
- **Juiciness**
- **Overall liking**
- *n* ~ 6,300

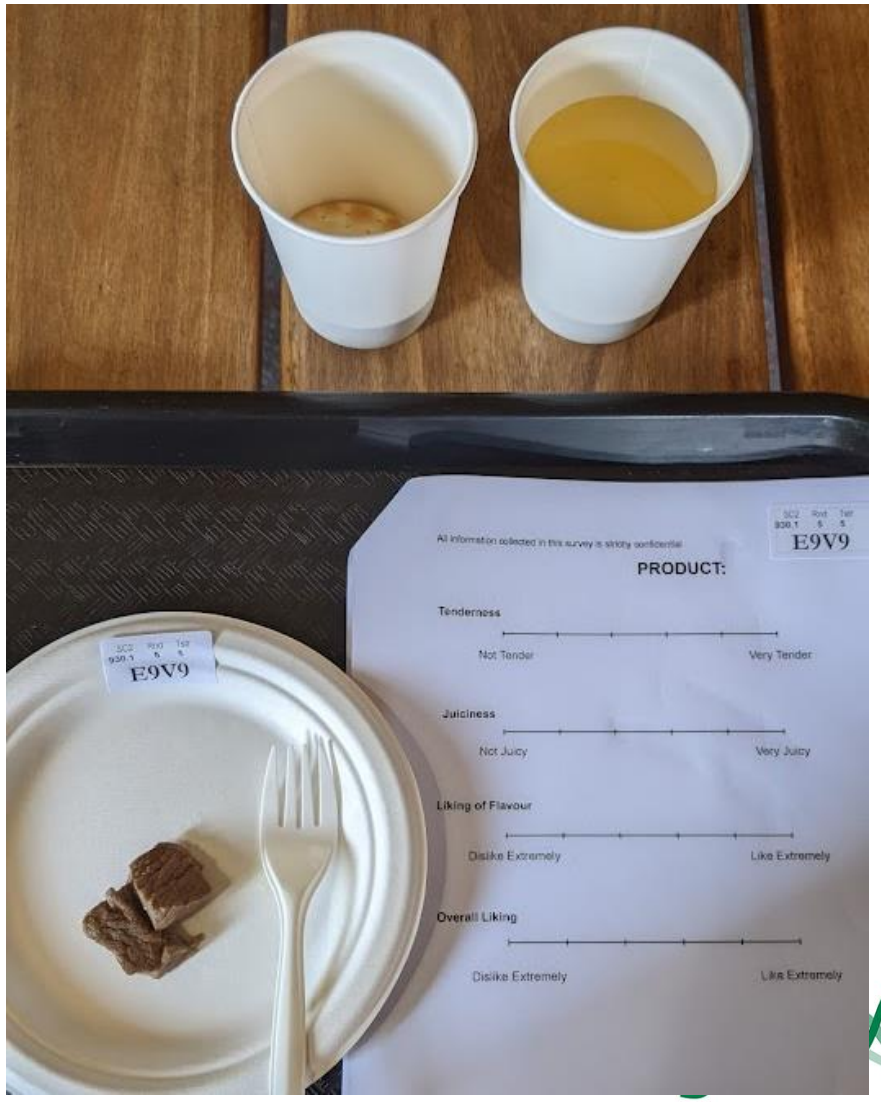
Loin
(*M. longissimus lumborum*)

Topside
(*Musculus semimembranosus*)

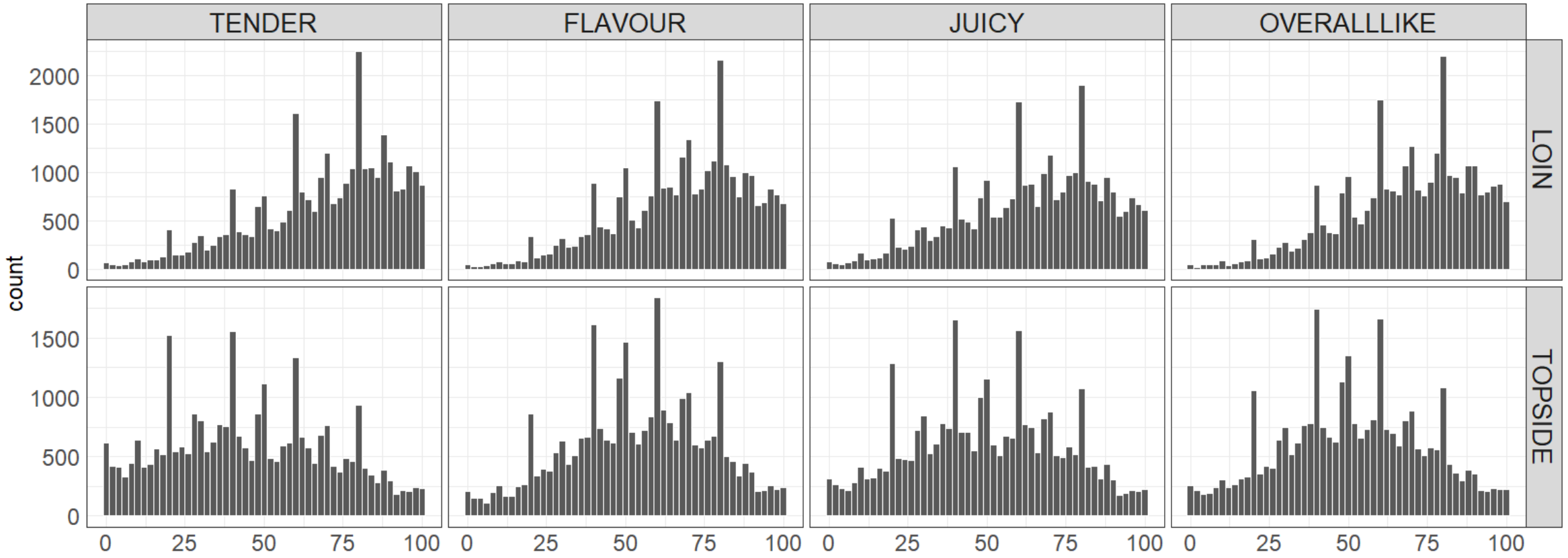


Consumer sensory trials

- Untrained consumers
- Randomised samples
- Multiple cooking methods



Results



- Wide variation
- Loin scored higher across all sensory traits (on average)

Genetic parameter estimates – consumer eating quality

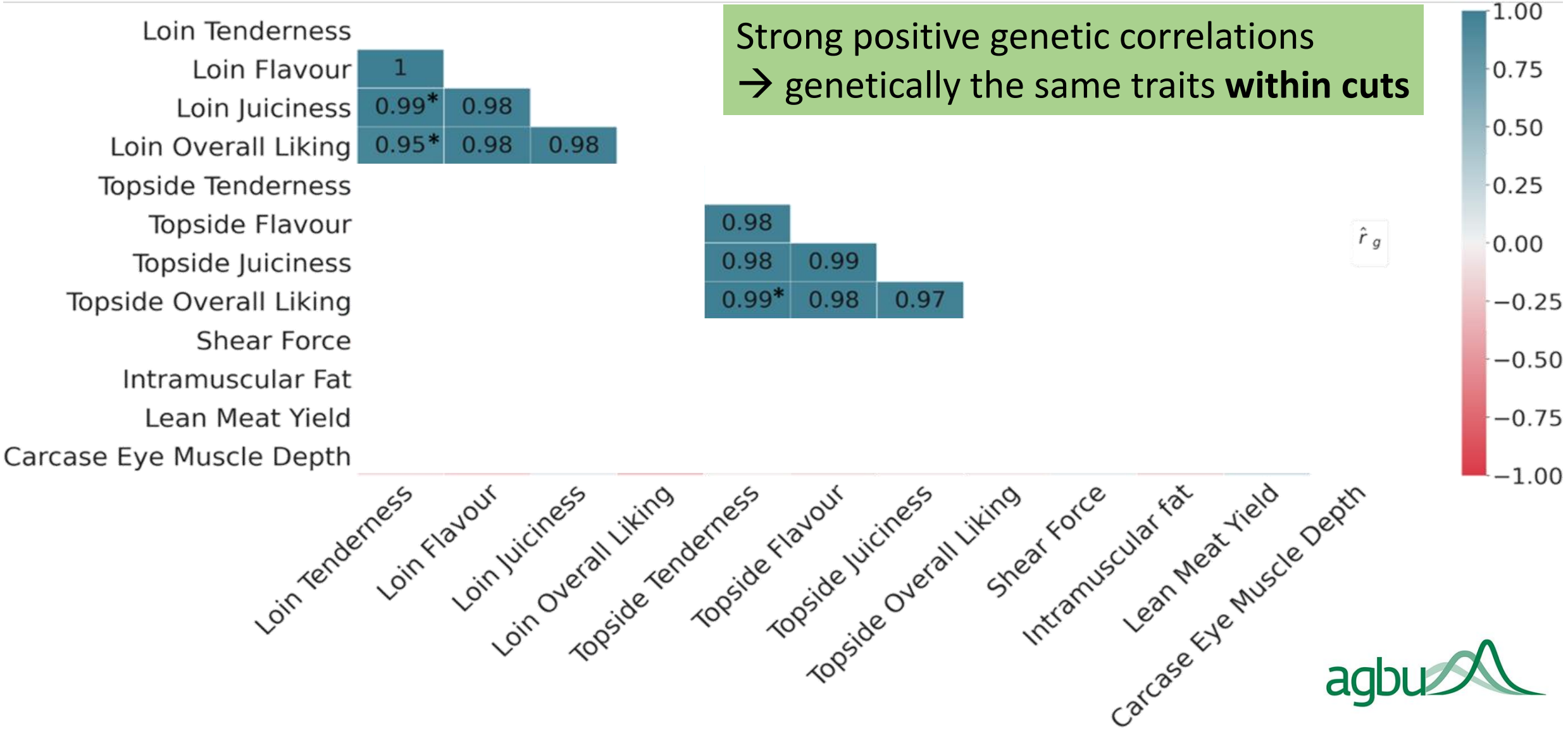
Trait	$\widehat{h}^2$
Lean meat yield	0.47 ± 0.09
Carcase eye muscle depth	0.28 ± 0.02
Intramuscular fat	0.57 ± 0.03
Shear force	0.28 ± 0.02

	Trait	$\widehat{h}^2$
LOIN	Tenderness	0.19 ± 0.05
	Flavour	0.12 ± 0.04
	Juiciness	0.17 ± 0.04
	Overall liking	0.14 ± 0.04
TOPSIDE	Tenderness	0.33 ± 0.06
	Flavour	0.16 ± 0.05
	Juiciness	0.22 ± 0.05
	Overall liking	0.25 ± 0.05

- Moderate heritability estimates
- Generally higher for topside, esp. tenderness

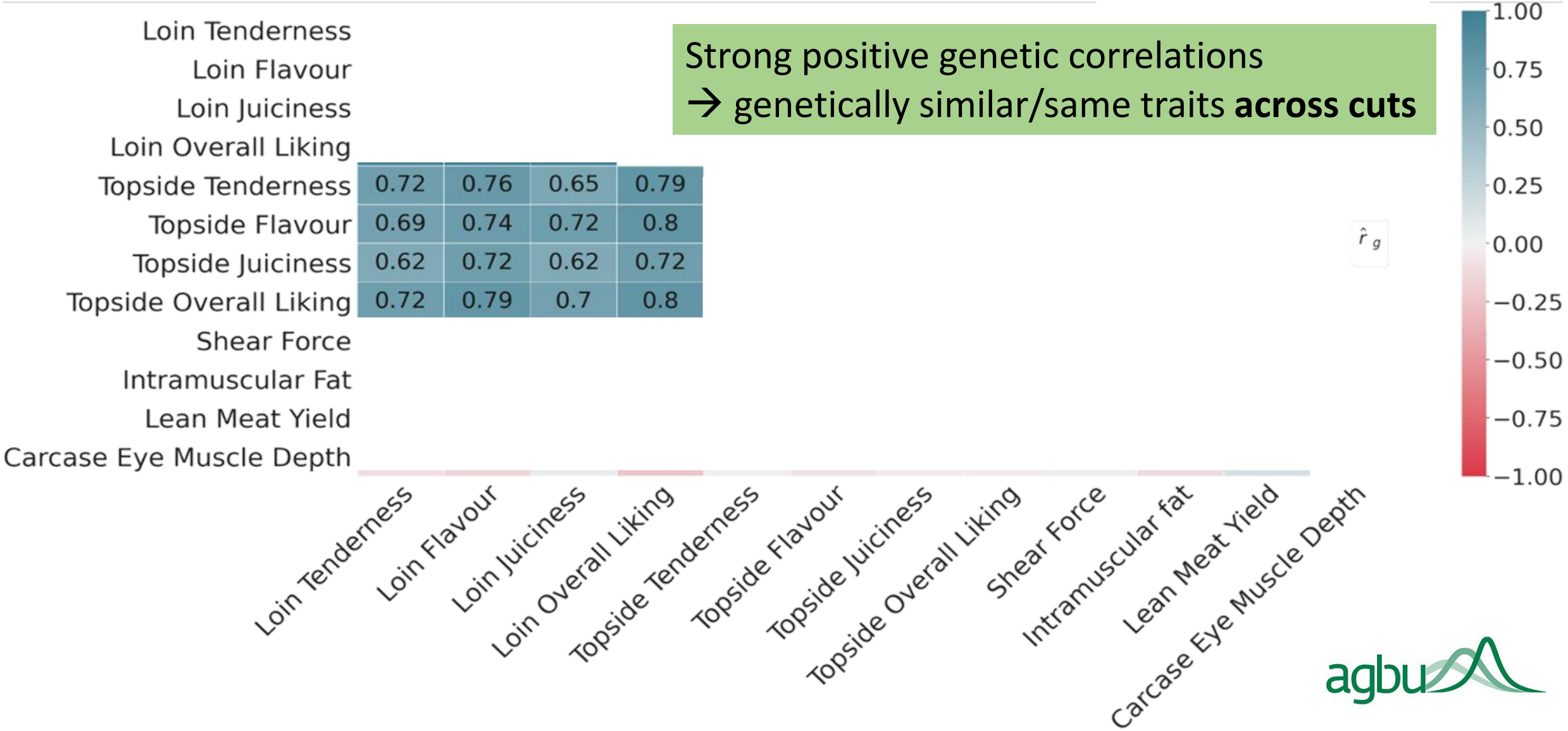
agbu

Genetic correlation estimates – within cuts



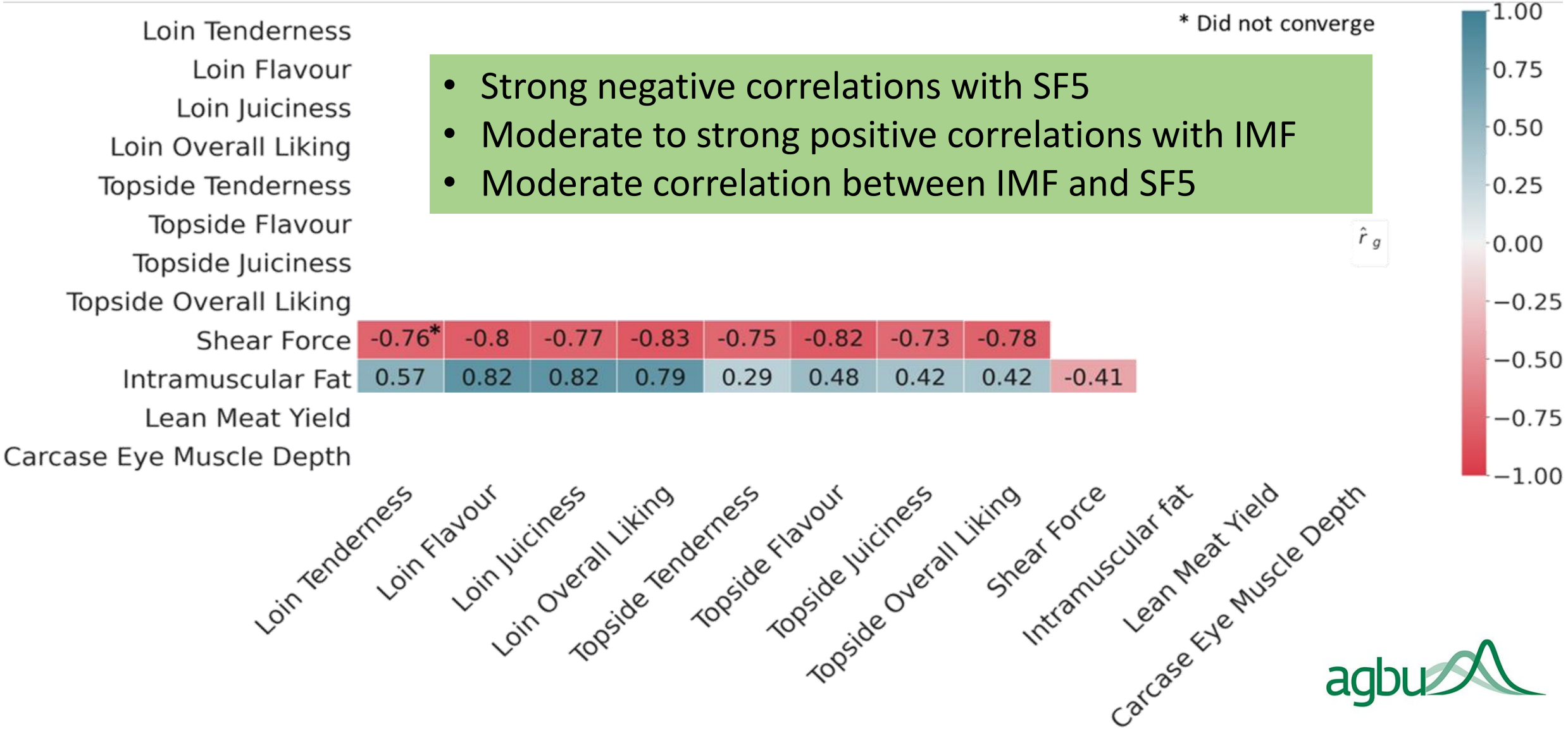
Strong positive genetic correlations
→ genetically the same traits **within cuts**

Genetic correlation estimates – across cuts



Strong positive genetic correlations
→ genetically similar/same traits **across cuts**

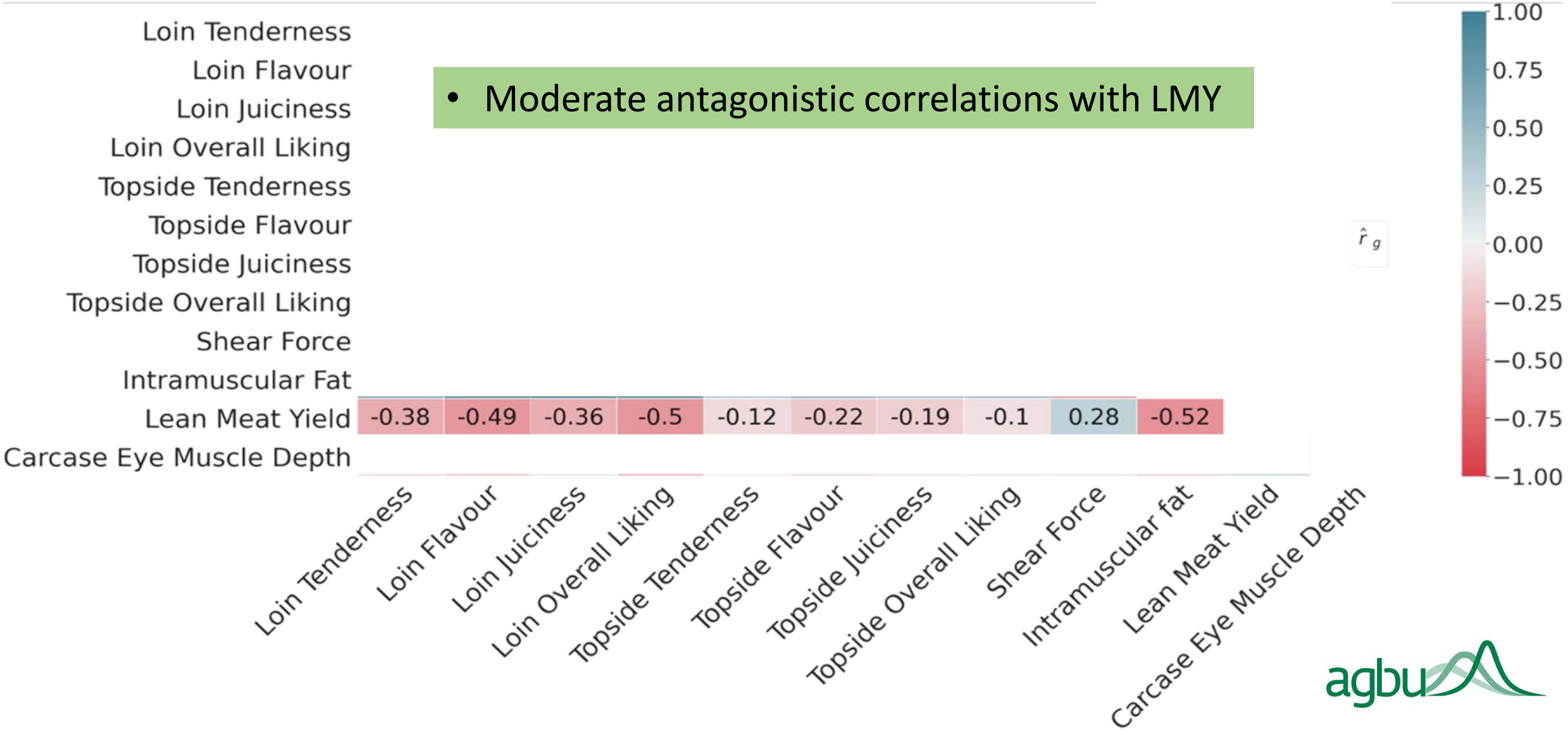
Consumer eating quality & objective eating quality



- Strong negative correlations with SF5
- Moderate to strong positive correlations with IMF
- Moderate correlation between IMF and SF5

Consumer eating quality & carcase composition

- Moderate antagonistic correlations with LMY



Consumers are willing to pay for quality!

	★★ Unsatisfactory	★★★ Good every day	★★★★ Better than every day	★★★★★ Premium
USA	46%	100%	150%	209%
China	57%	100%	147%	212%
Australia	53%	100%	141%	189%

O'Reilly, Pannier et al 2016

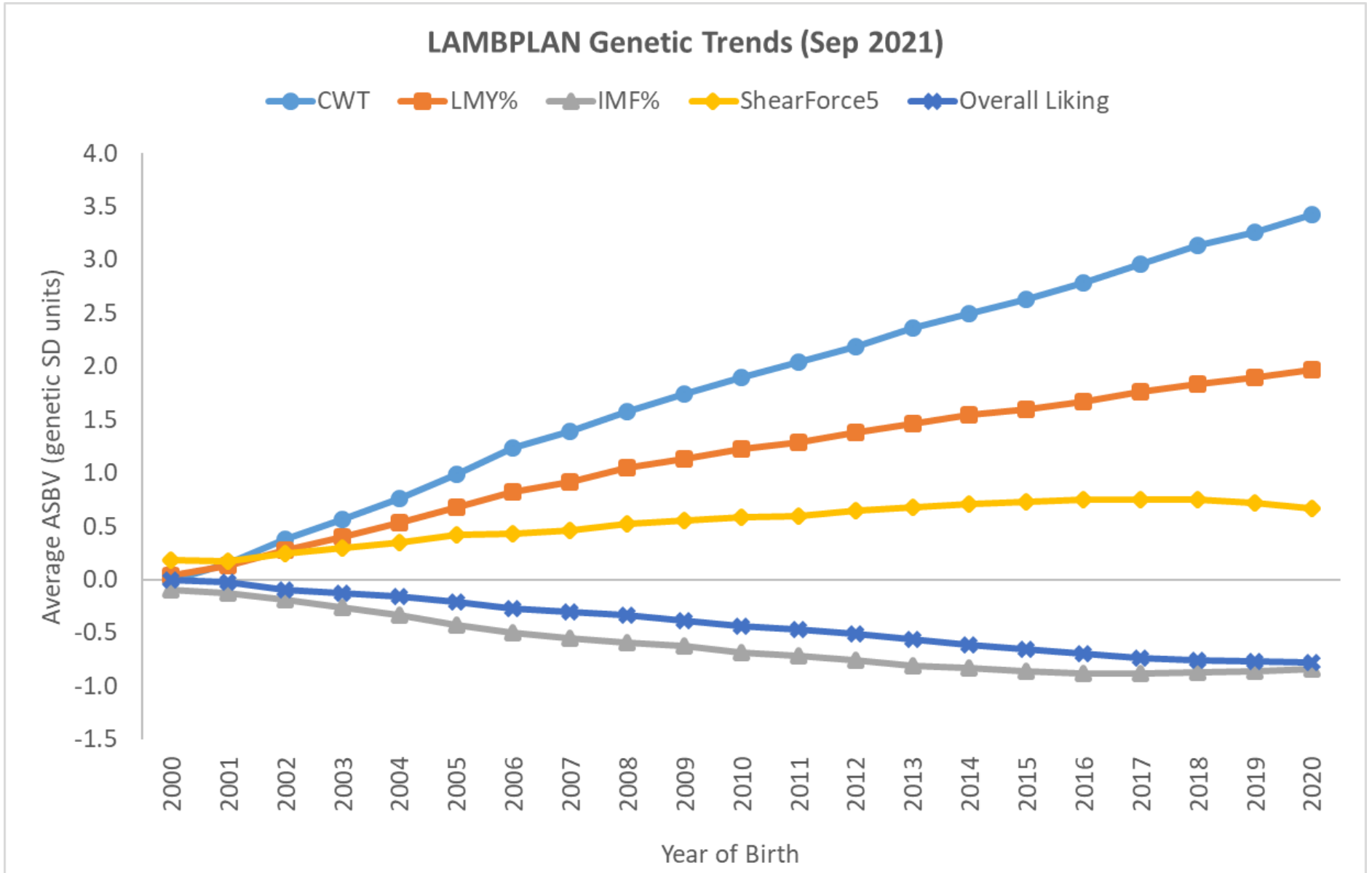
2. Simultaneous genetic improvement for LMY and EQ

1) ASBVs and Indexes

2) Genomic prediction

MEAT & LIVESTOCK AUSTRALIA

LAMBPLAN Genetics Trends 2000 - 2021



Yield traits

Carcase weight

Lean Meat Yield

Eating Quality traits

Shear Force

Intramuscular Fat

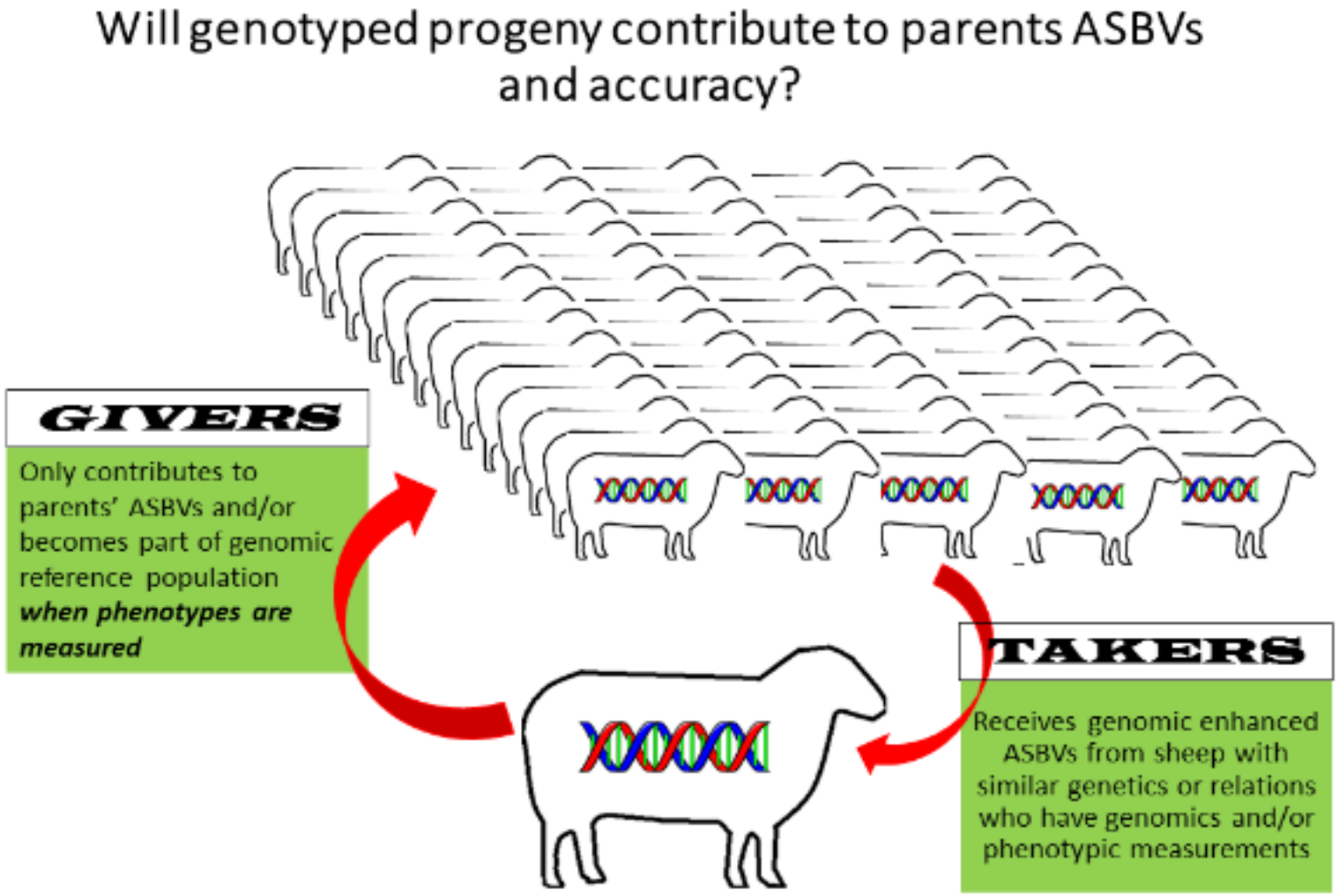
agbu

Balance: Genetic and Phenotypic

Breeding for LMY and EQ

- Good information for both LMY and EQ critical for balanced genetic progress

ASBVs and genomics have a give and take relationship



Single Step Australian Sheep Breeding Values (ASBVs)

Animal performance

Carcass measurements

Consumer eating quality

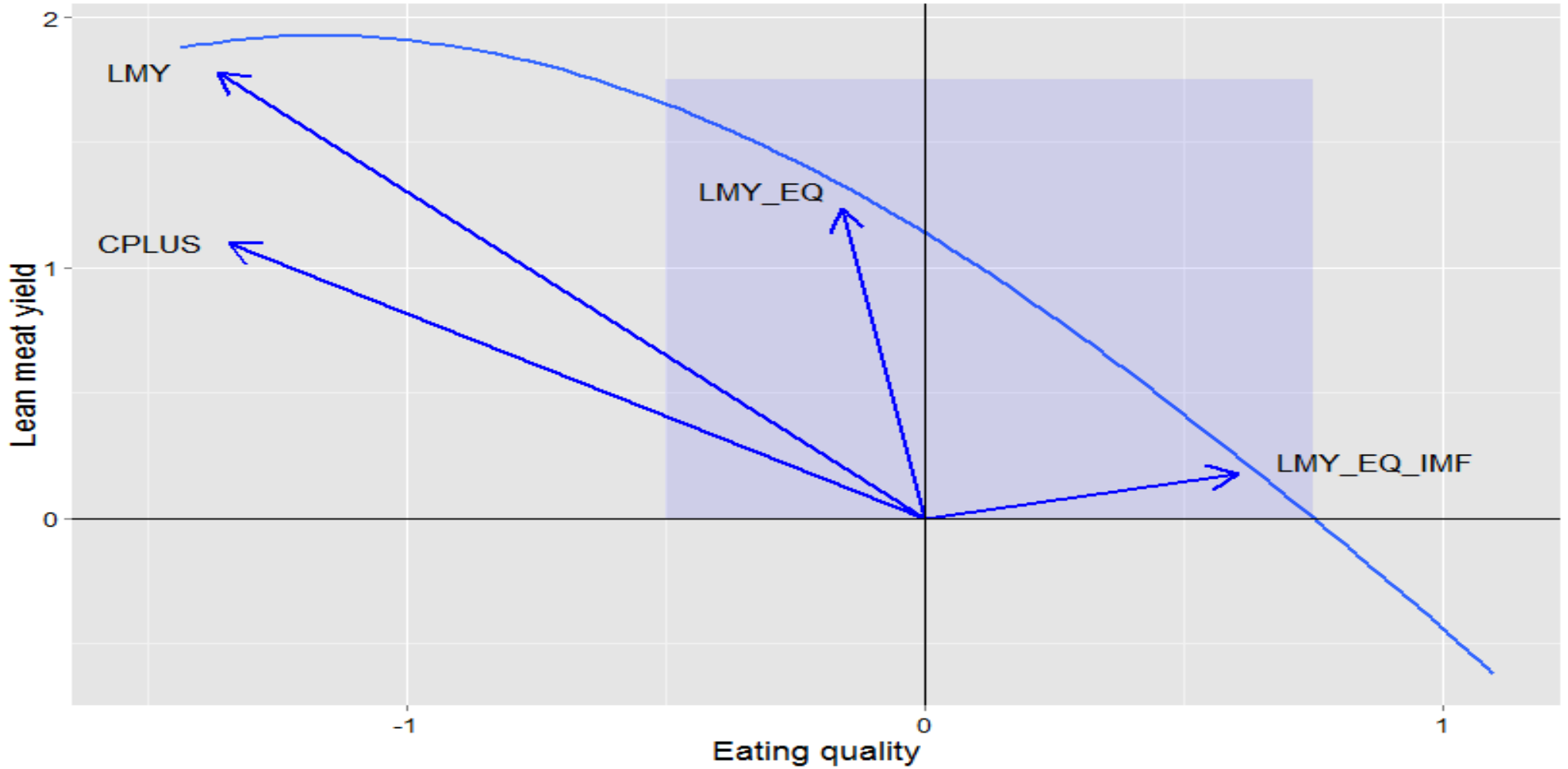
Resource flocks and ram breeders

Genomic testing

EQ index = Trait economic values X

LAMBPLAN ASBV

Antagonistic relationship between yield and EQ makes joint improvement difficult



Eating Quality in sheep – an example of trait development

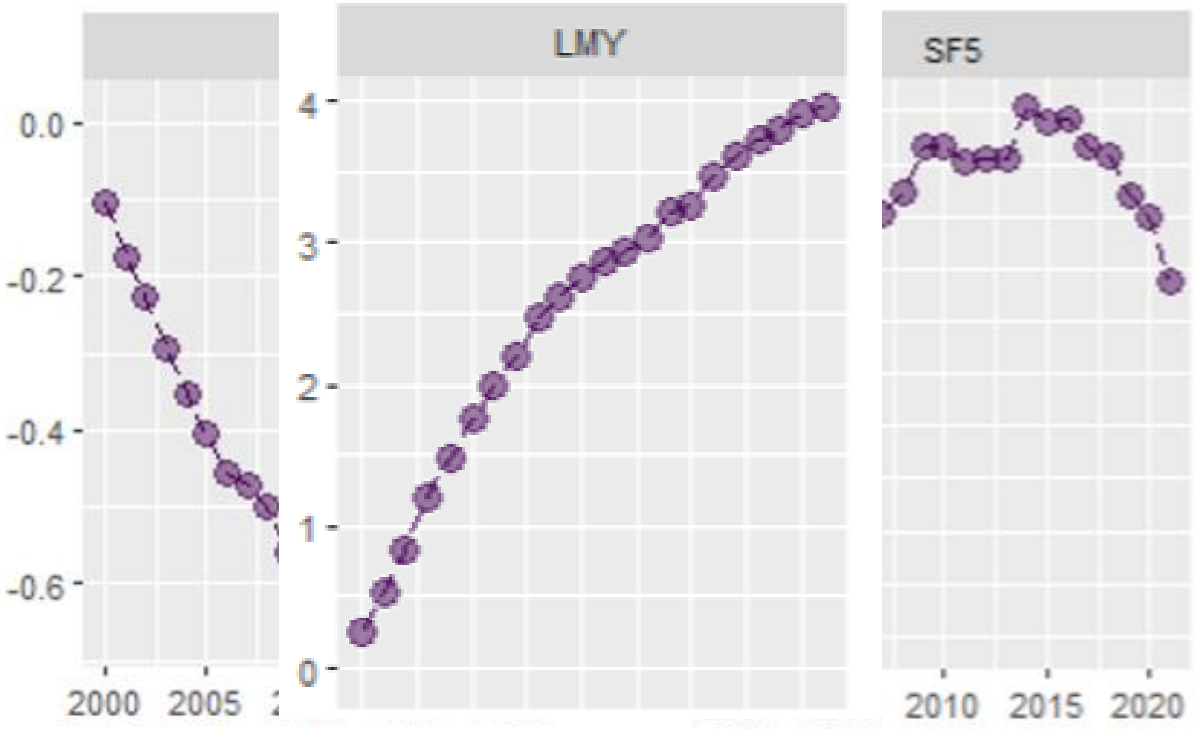
2008-2012
Begin measuring EQ in lamb

2012
First Research Breeding values become available

2012-onwards
Breeders begin to select for EQ

2016
Full single step ASBVs for EQ

2021
First market signals for EQ



Ram sales

- This currently comes at a cost for ram breeders

- price signals critical in the long term
  - Ram breeding
  - Commercial producers

3. Industry wide approach

1) MSA

2) Feedback signals

MEAT & LIVESTOCK AUSTRALIA

Lamb MSA

Yield

Eating Quality

- **May underpin price signals**

- Grading
- Sorting
- Cutting
- Marketing

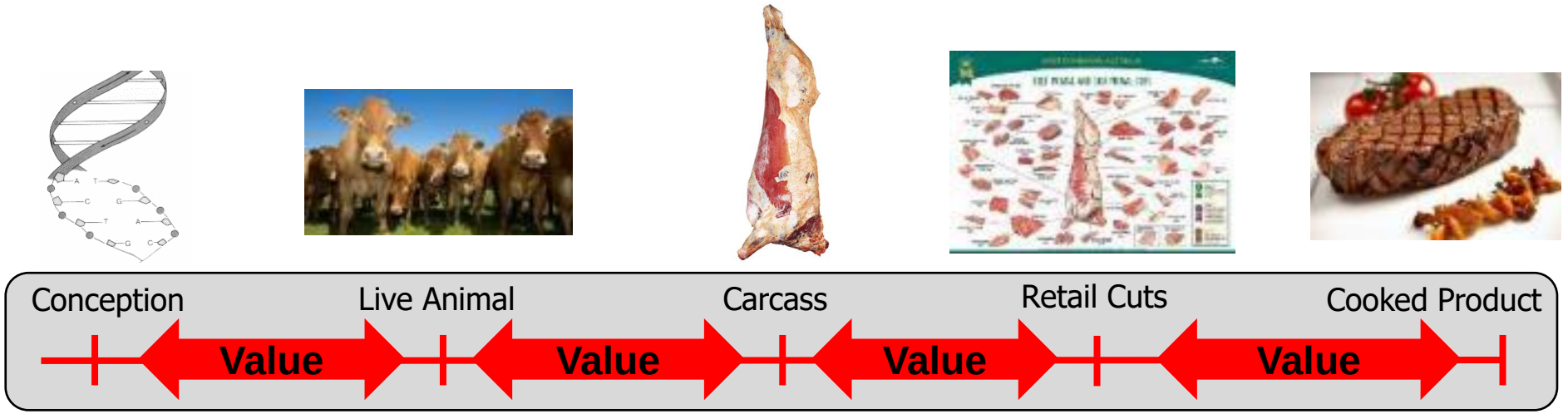
Collaborations along the supply chain

- Accelerate technology development and use
- Profitability for all partners in the meat value chain

agbu

Precision measurement
from paddock/pen to plate

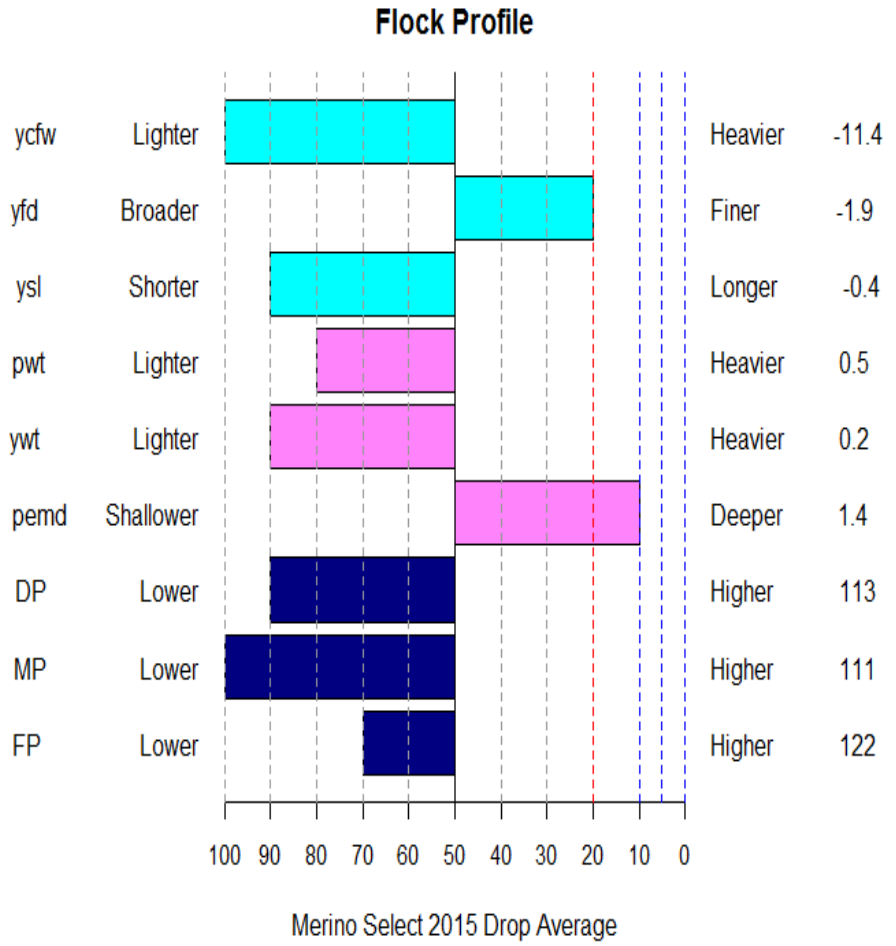
- Predict quality and amount of final product



Massive variation is quantity and quality of carcasses at all points

Flock Profiling - A Commercial Reality in Merinos

- 20 animals from drop randomly genotyped
- Reflects the average ASBVs of sires purchased
- Provides a genetic benchmark for future ram purchases

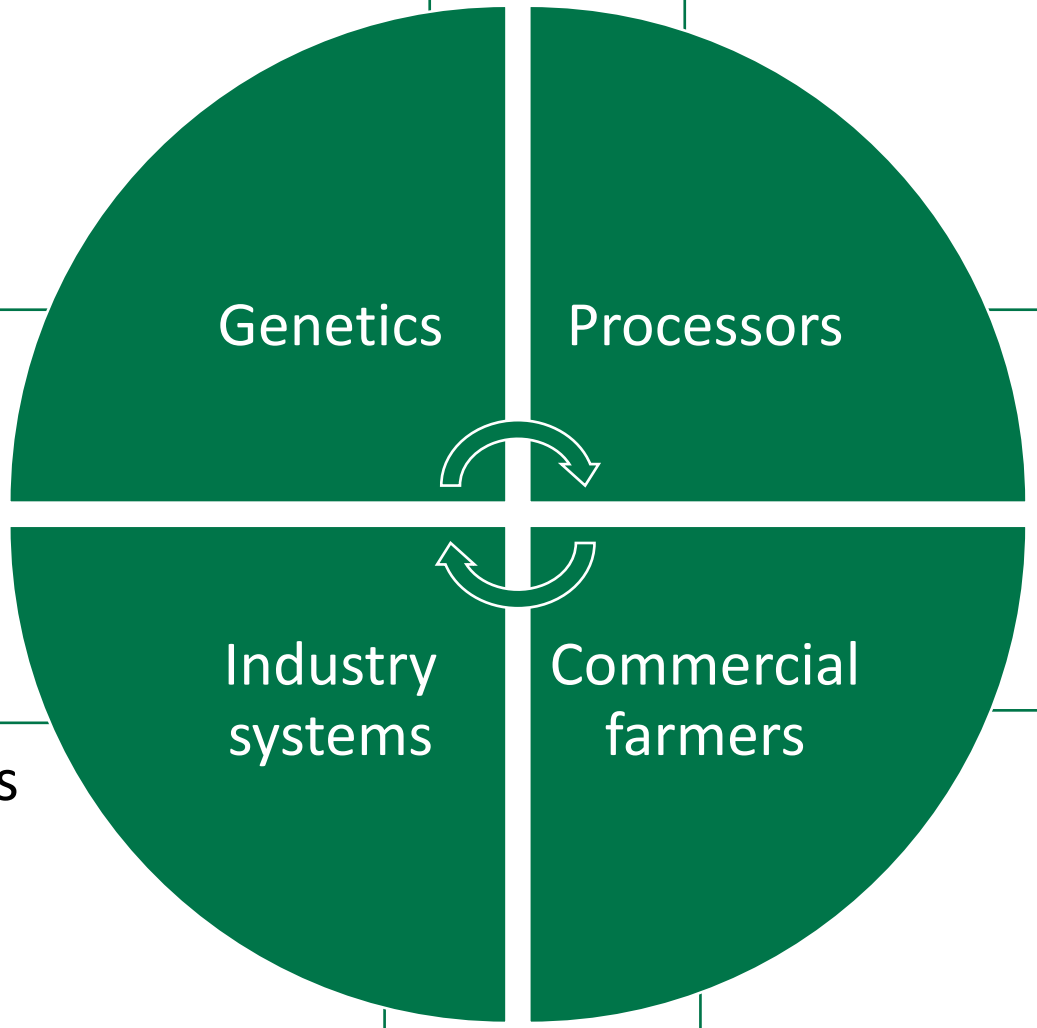


FlockProfileTest

Bringing it all together

- ASBVs for LMY and EQ
- Selection Indexes
- Genomic tools
- Resource populations

- Objective measurement
- Carcase value calculators
- Optimization tools
- Implementation support



- Calibration and standards
- MSA
- Feedback systems
- Integrity

- Feedback
- Rams with ASBVs
- Other genetic tools
- Adoption programs

Conclusions

- Eating quality is growing in importance
- Balanced selection for carcass yield and lamb eating quality now possible:
  - Genomically enhanced breeding values and indexes
- Feedback from supply chain to producers critical
  - Price signals for breeders and commercial producers

Innovation in Valuing and Breeding for Eating Quality in Lamb

1. LMY and EQ in lamb	Moving away from a commodity product
2. Genetic improvement	Driving good information for both LMY and EQ
2. Industry application	Better feedback for better decisions

Technology provides an opportunity – if we have systems to use the data!

agbu

Acknowledgements

+ the many staff involved
in the funding, projects
and collecting data

MEAT & LIVESTOCK AUSTRALIA

SHEEP CRC

agbu

University of New England

Murdoch University

NSW Government Department of Primary Industries