International Livestock Conference

Calgary Stampede

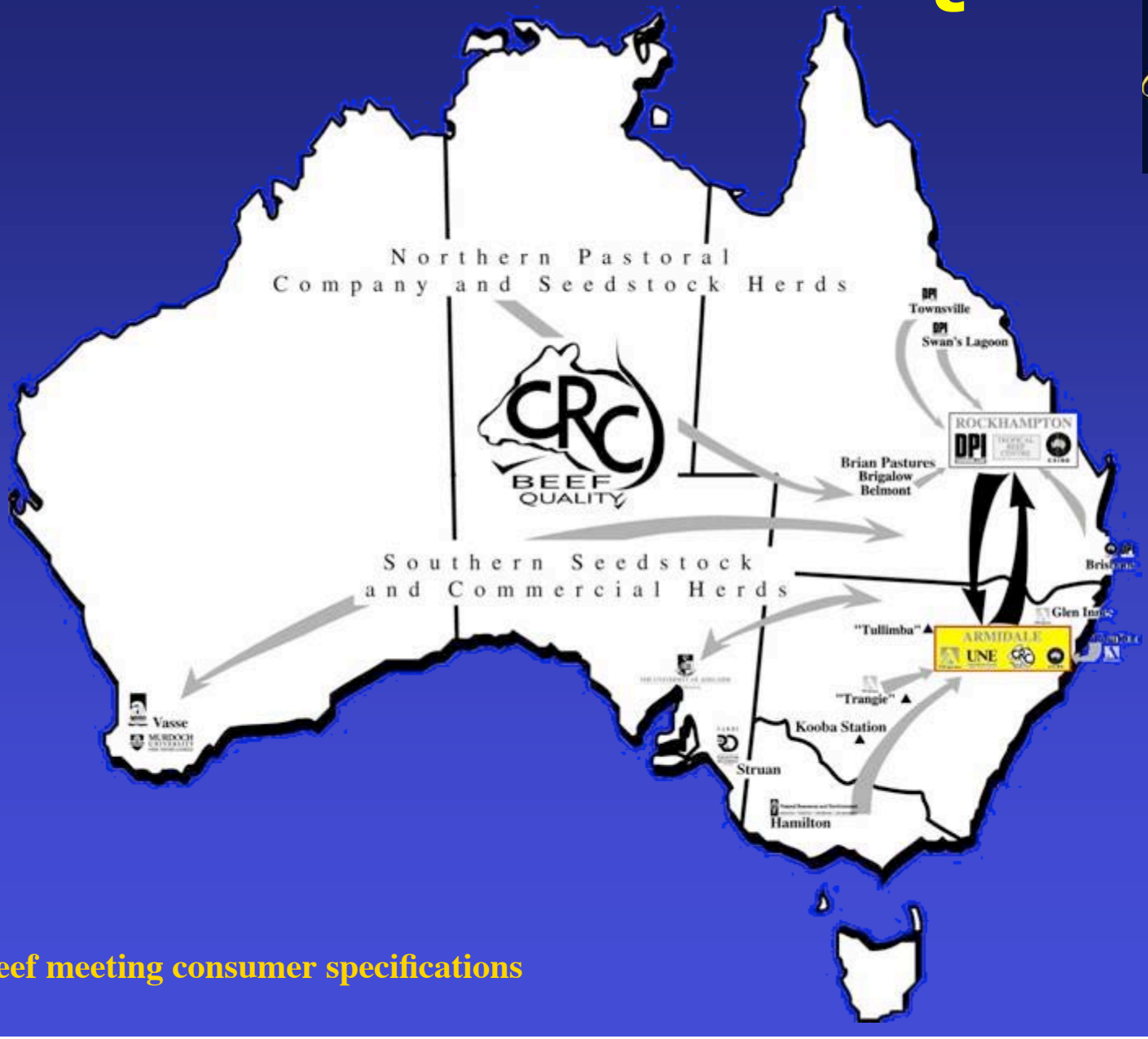
July 14, 2006

Professor Bernie Bindon

Chief Executive Officer

CRC for Cattle and Beef Quality

CRC for Cattle and Beef Quality



Beef meeting consumer specifications

Core Partners

Armidale

Grafton

Trangie

Wagga Wagga

Camden

Armidale

Brisbane

Rockhampton

Brisbane

Julia Creek

Rockhampton

Townsville

Gayndah

Armidale

Beef meeting consumer specifications

Supporting Partners

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

ADELAIDE UNIVERSITY AUSTRALIA

State Government Victoria Department of Primary Industries

MURDOCH UNIVERSITY
PERTH, WESTERN AUSTRALIA

Agriculture
WESTERN AUSTRALIA

Financial Support of Beef CRC

Contributors	CRCI (1993-1999) ($M)	CRCII (1999-2006) ($M)	CRCIII (2005-2012) ($M)
Cash Sponsors			
• Commonwealth (CRC)	21.0	16.0	30
• MRC/AMLC; MLA/ALFA	2.3	6.3	12
• **Northern Pastoral Group**	0.4	3.1	4
• **Other Industry Sponsors**	3.6	2.8	15
• **ACIAR**	-	1.3	-
In Kind			
• **Core Partners**	35.7	45.6	60
• **Supporting Participants**	-	9.5	-
TOTAL	63.1	83.3	121

Industry Sponsors

Industry Bodies

Funding Bodies

- Aust Commonwealth Government
- Meat Processors
- Feedlots
- Meat Retailers
- Agribusiness

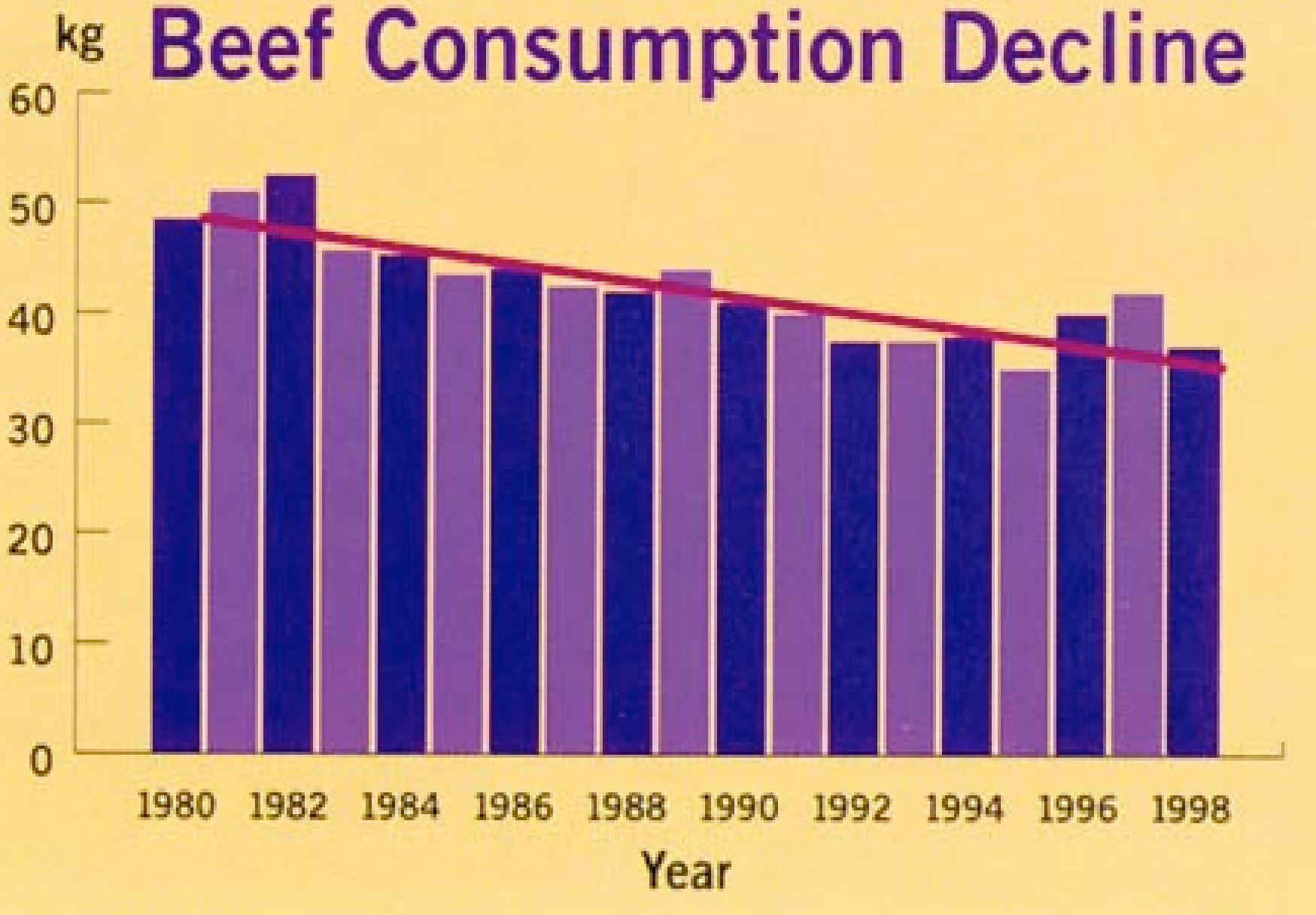
The Australian Beef Industry

- $9.6 billion industry
- Prosperity of 70,000 beef SMEs in rural and regional Australia
- World's No 1. Beef Trader
  - 2.3% world cattle
  - 23% world beef trade (exports to 110 countries)
- 300,000 jobs in Australia directly and indirectly from the beef sector

The Industry Problem:

- Liberalisation of Japanese and Korean markets
- Consumer dissatisfaction with eating quality and consistency of Australian beef

Australian Domestic Beef Consumption



CRC Imperatives

- Scientific Excellence ..... ✓
- Cooperation between Institutions ..... ✓
- Major National Issue ..... ✓
- Industry Involvement ..... ✓
- Industry-driven Board ..... ✓
- Big Ticket Item focus ..... ✓

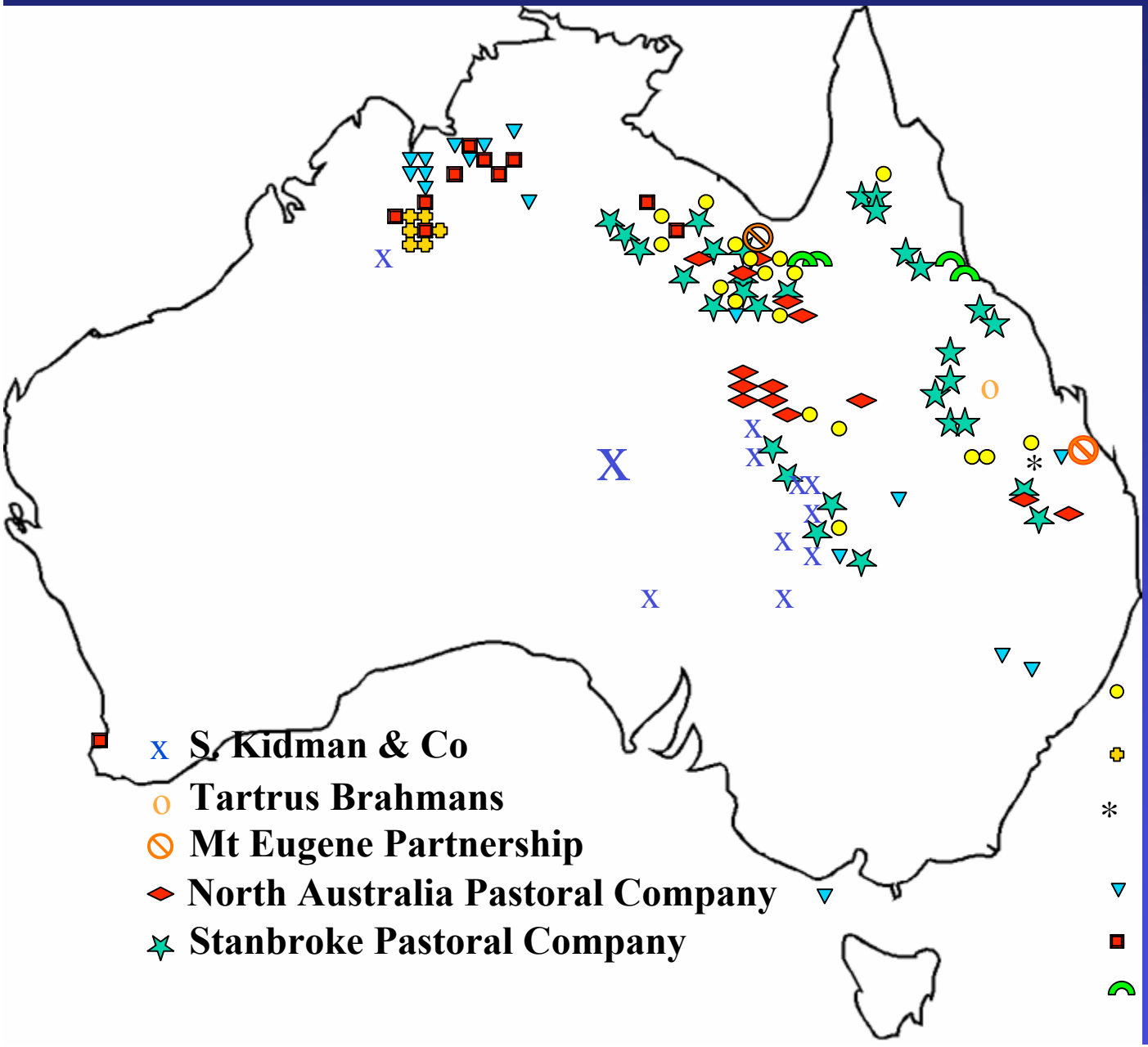
Beef meeting consumer specifications

Industry Sponsors

Pastoral Enterprises

- Australian Agricultural Co
- Balmoral Stations
- Consolidated Pastoral Co
- Heytesbury Beef
- Hillgrove Pastoral Co
- Kooba Station (AgReserves)
- Mt Eugene Belmont Reds
- Tartrus Brahmans
- North Australian Pastoral Co
- S Kidman & Co
- Stanbroke Pastoral Company
- Twynam Pastoral Company
- Acton Land & Cattle Company
- GRM International
- Alcoa Farmlands
- Cona Creek Brahmans

Northern Pastoral Group ~ Property Locations



Science to guarantee eating quality

Conception

Genetics

Nutrition/environment

Pre-slaughter factors

Post-slaughter factors

Chilling

Processing/value adding

Cooking

Consumption

Critical Control Points

Consumer Feedback

CRC Progeny tests for Meat Quality

Straightbreeding Project
(AA, HH, SH, MG, BB, SG, BR)
n=~10,000

Crossbreeding Project
(AA,HH, SH, CH, LL, SG, CB, BR, BB)
n=~2,000

Common Sires
(Angus, Hereford, Shorthorn,
Brahman, Santa Gertrudis, Belmont Red)

Common backgrounding
(north and south)

Grass finish

Grain finish

Slaughter at 3 market weights

Carcase and meat quality, eating quality

← Genetic and non-genetic outcomes

MSA outcomes →

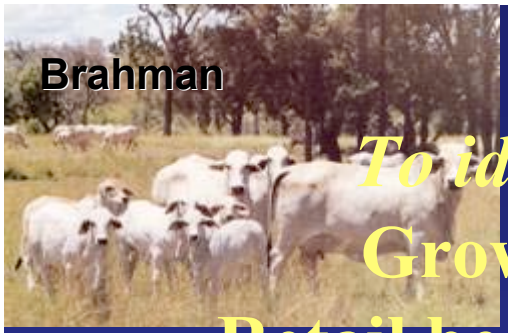
Beef meeting consumer specifications

CRC Progeny Tests

To identify the cattle with the genes for:

Growth • Feed efficiency • Marbling

Retail beef yield • Tenderness • Eating quality



Achievement Highlights

- Leadership in marbling biology
- Leadership in tenderness biology
- Leadership in feed efficiency
- Underpinning science for MSA Grading
- Leadership in genetic marker technology

Achievement Highlights

- Australia's largest integrated beef research project
- Delivery of technologies to end-users
- Excellence in Meat Science education/training
  - Three Industry-funded Chairs ($450k / year)

CRC Commercial & Patented Products

- BRD Vaccines – *Pasteurella hemolytica*
- BRD Vaccines – Pestivirus
- Acidosis Vaccine – *Streptococcus bovis*
- Gene Marker tests
- Feed Efficiency measurement technology
- Flight Time measure of temperament

Beef meeting consumer specifications

Genetic Improvement of Tenderness

- EBVs for 7 breeds released - BREEDPLAN
- Heritability defined
- Indirect selection opportunities...
  - Meat colour (r_g's = - 0.43)
  - Flight time (r_g's = - 0.53)
  - Marbling (r_g's = - 0.34)
- Candidate genes
  - myofibrillar toughness
  - collagen toughness
  - calpain SNPs


BEEF 91 AUSTRALIAN
AUSTRALIAN
GRAND CHAMPION

CRC Outcomes

Breeding Better Cattle

- Genetic parameters (h^2 and *r*gs) to define the limits of genetic improvement of meat quality traits
- Blueprint for straight-breeding and cross-breeding to improve:
  - ✓ Retail Beef Yield
  - ✓ IMF %
  - ✓ Tenderness
  - ✓ Eating Quality
  - ✓ Net Feed Efficiency
- Outstanding Sires (EBVs) in 7 cattle breeds to improve carcase and meat quality traits

Beef meeting consumer specifications

Genetics and FINISHING system

IMF%	Pasture	Grain
Pasture	.31	1.0
Grain		.42

- Greater genetic expression in grain finished
- No re-ranking of sires across finishing

CRC Outcomes

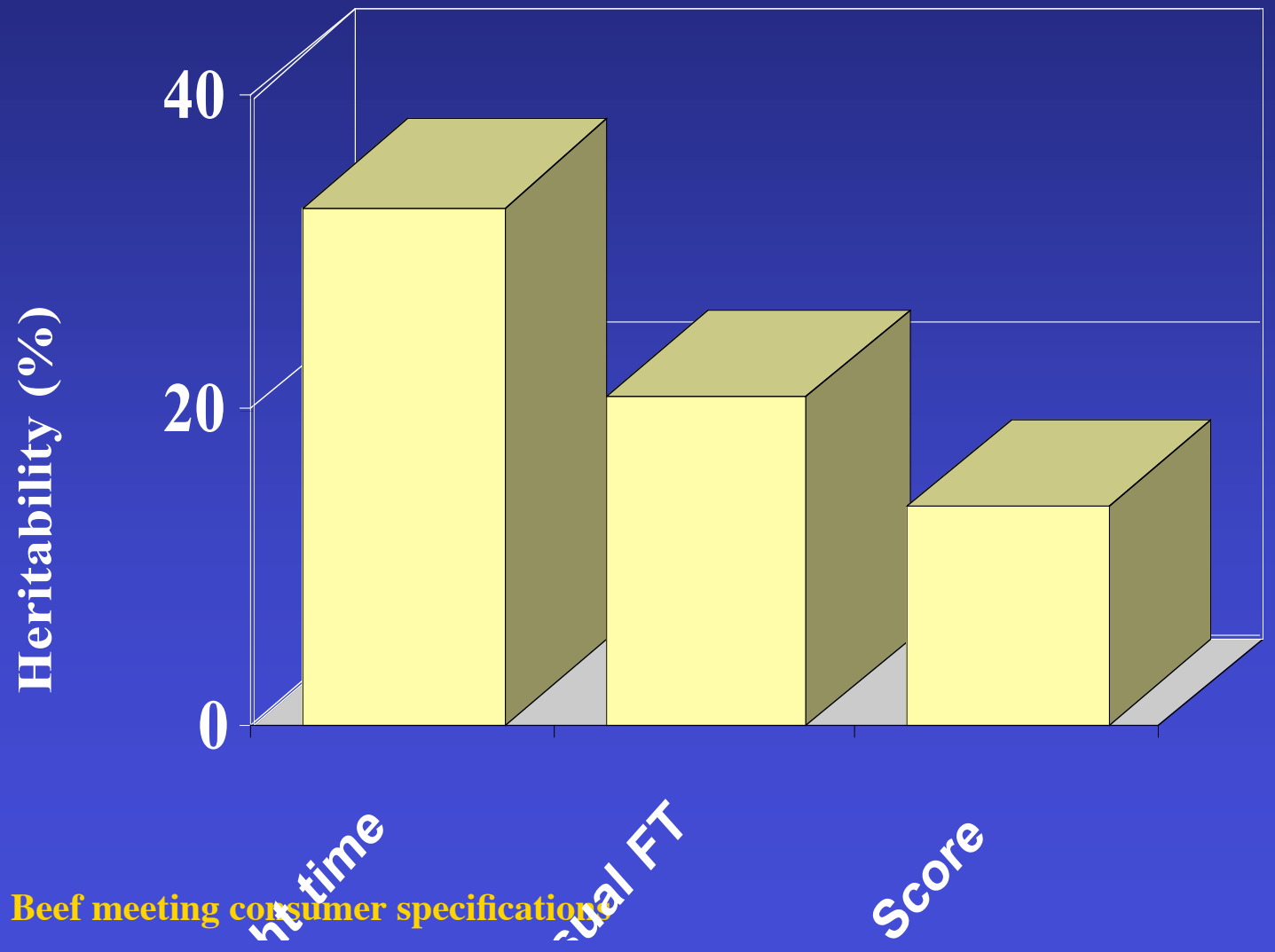
Breeding Better Cattle

- Sire breed effects on beef quality in Brahman outcrossing, including MSA effects
- Linked Gene Markers for RBY, IMF % and Tenderness
- Two Direct Gene Markers for Tenderness

Beef meeting consumer specifications

Heritabilities of temperament scores

(*tropically adapted breeds; n = 3,594*)

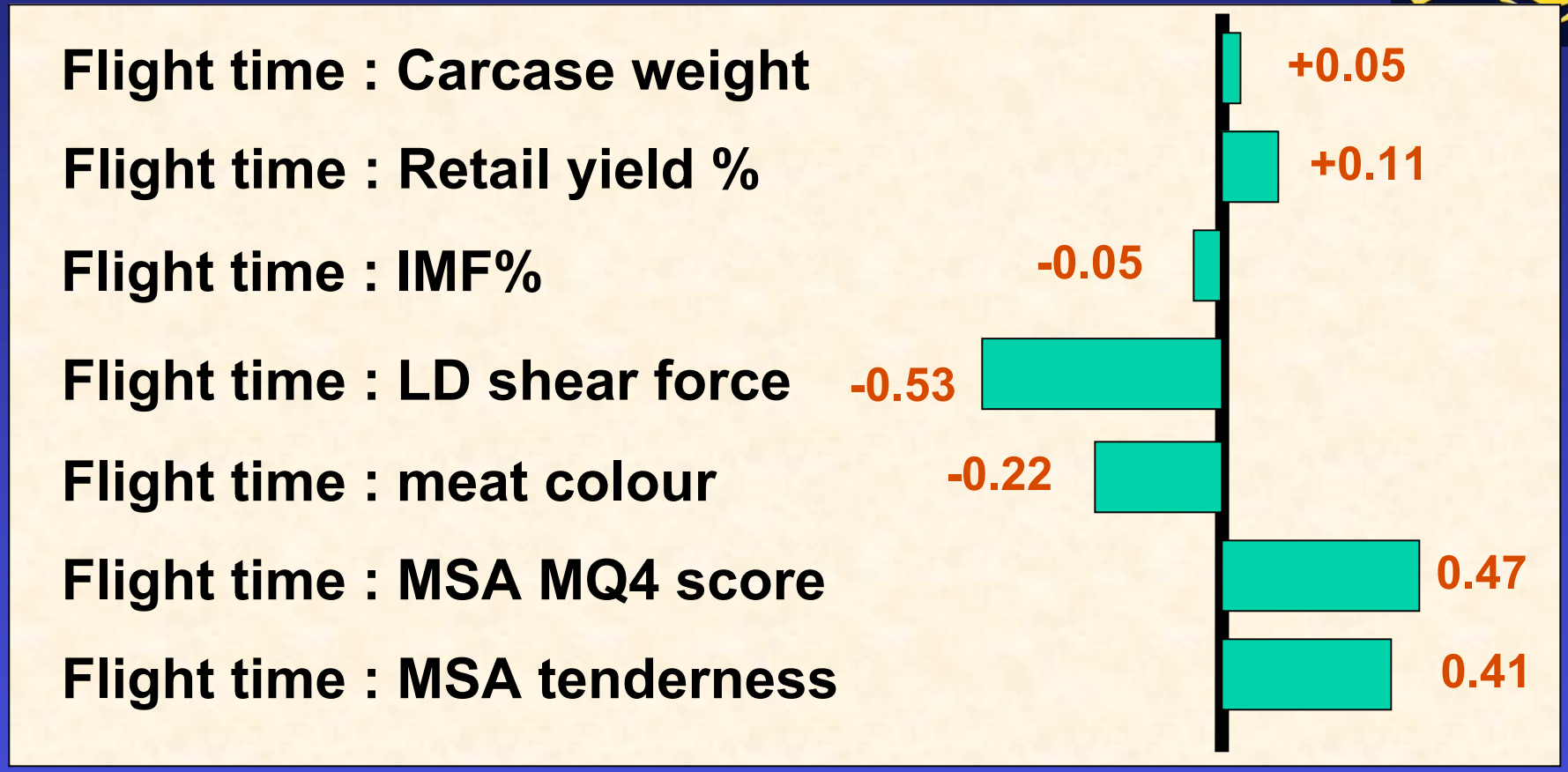


Beef meeting consumer specifications

Measuring Temperament (Flight time)

Genetic relationships

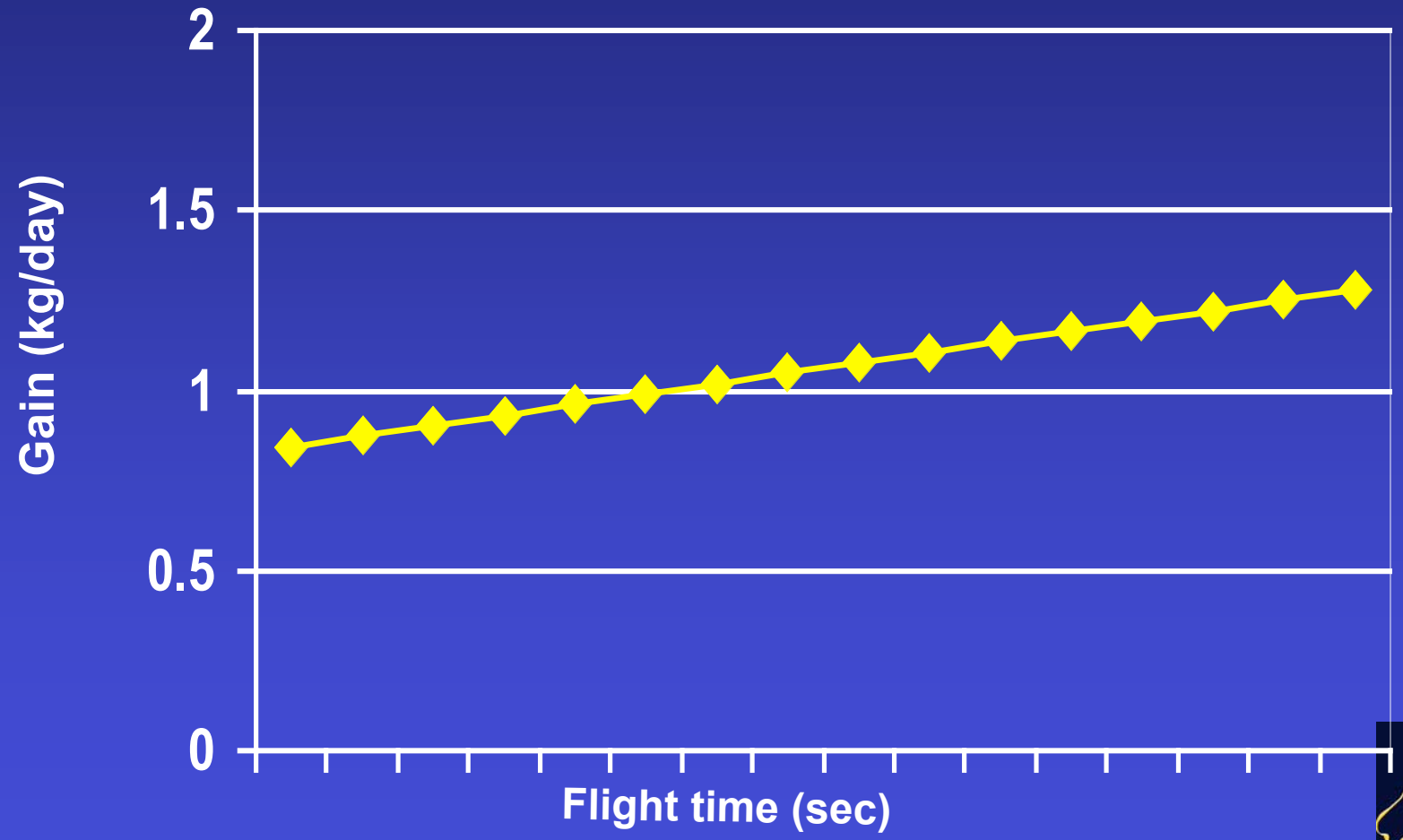
(Range -1.0 to +1.0)



Phenotypic relationships close to 0, probably because best-practice processing overcomes toughness due to fast flight times

Relationship with feedlot daily gain

(Linear relationship P<0.001; quadratic ß n.s.; difference between best and worst = 0.38 kg/day; similar in temperate and tropical cattle)



Beef meeting consumer specifications

CRC BEEF QUALITY

Gene Marker Technology

Bovine | Human | Mouse | Other

Bovine DNA Sequence

Marker(s) for the Gene

Three forms of the marker are observed. Animals are genotyped (e.g. 23, 12, 13, 22) to study associations with meat quality traits

Gene Discovery: CRC Gene Marker Pipeline

MAP → **IDENTIFY** → **COMMERCIALISE**

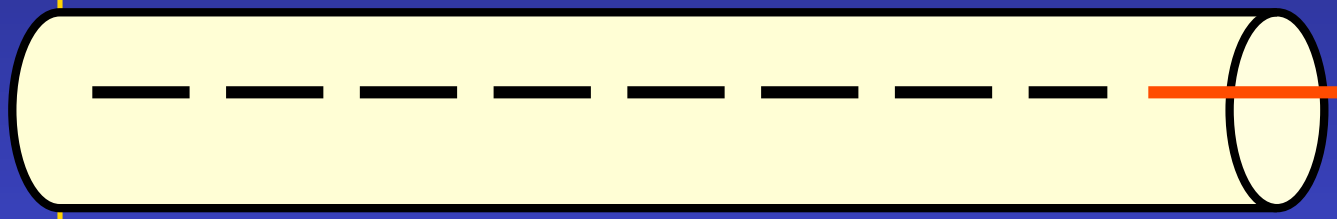
Broad regions

Fine-scale mapping

Test specific genes

Statistical Analyses

Patent Protection (DNA Test)



Commercial testing of genes (Validation)

Fertility

Tick/worm resistance

Net Feed Intake

Retail Beef Yield

Carcase & meat quality

RORC Marbling

TG5 Marbling

LOX Tenderness

CAST3 Tenderness

~~**LEPTIN & SCD Marbling**~~

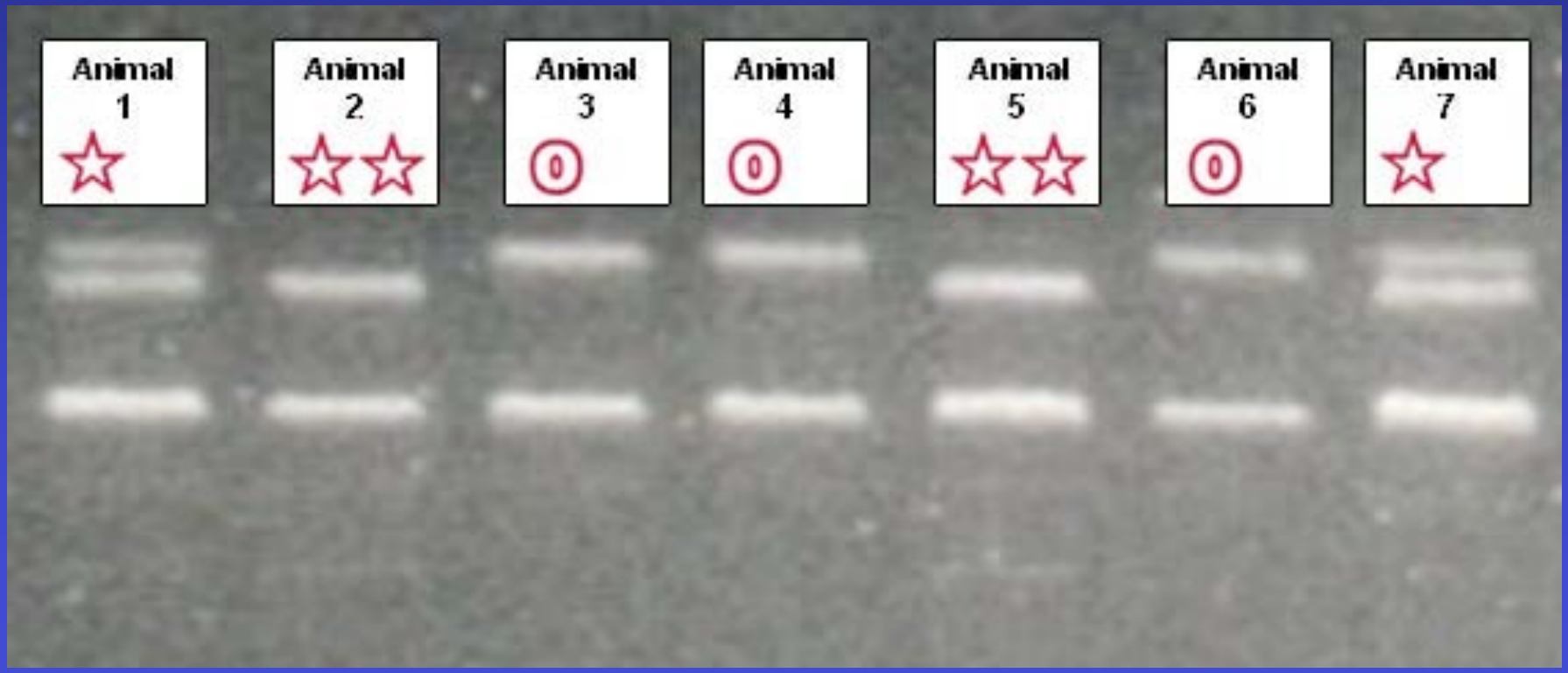
CALPN1 Tenderness

Beef meeting consumer specifications

Beef Cattle Gene Discovery

- Gene Marker "Families" set up (1990)
- Measure many traits
- Markers linked to traits (QTL) (ie Carcase value, RBY, EMA, Fat Colour, Marbling, Tenderness, Feed Efficiency)
- Fine scale mapping of chromosome "regions"
- Validation in CRC database
- "Positional" candidate genes
- Identify (and patent) Gene Polymorphism
- Demonstrate size of effect on trait
- Commercial release of DNA test (2000) [Best bets: Marbling, Tenderness, RBY, NFCE]

…. Gene for marbling



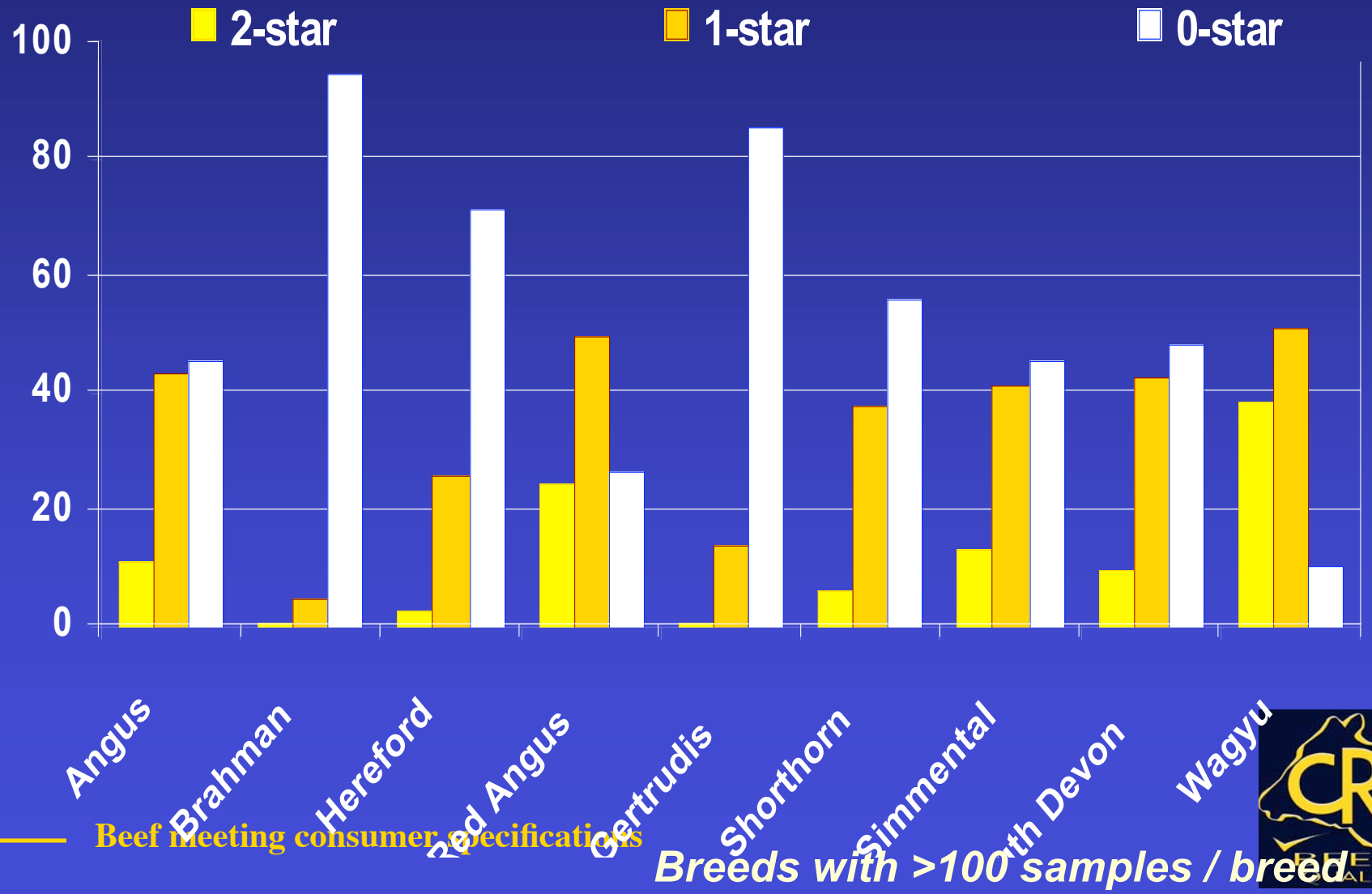
Beef meeting consumer specifications

…. Gene for marbling public results

Breed	☆☆	☆	0
Wagyu	39 (55%)	28	4
Angus	54 (17%)	199	68
Shorthorn	26 (13%)	97	84

Beef meeting consumer specifications

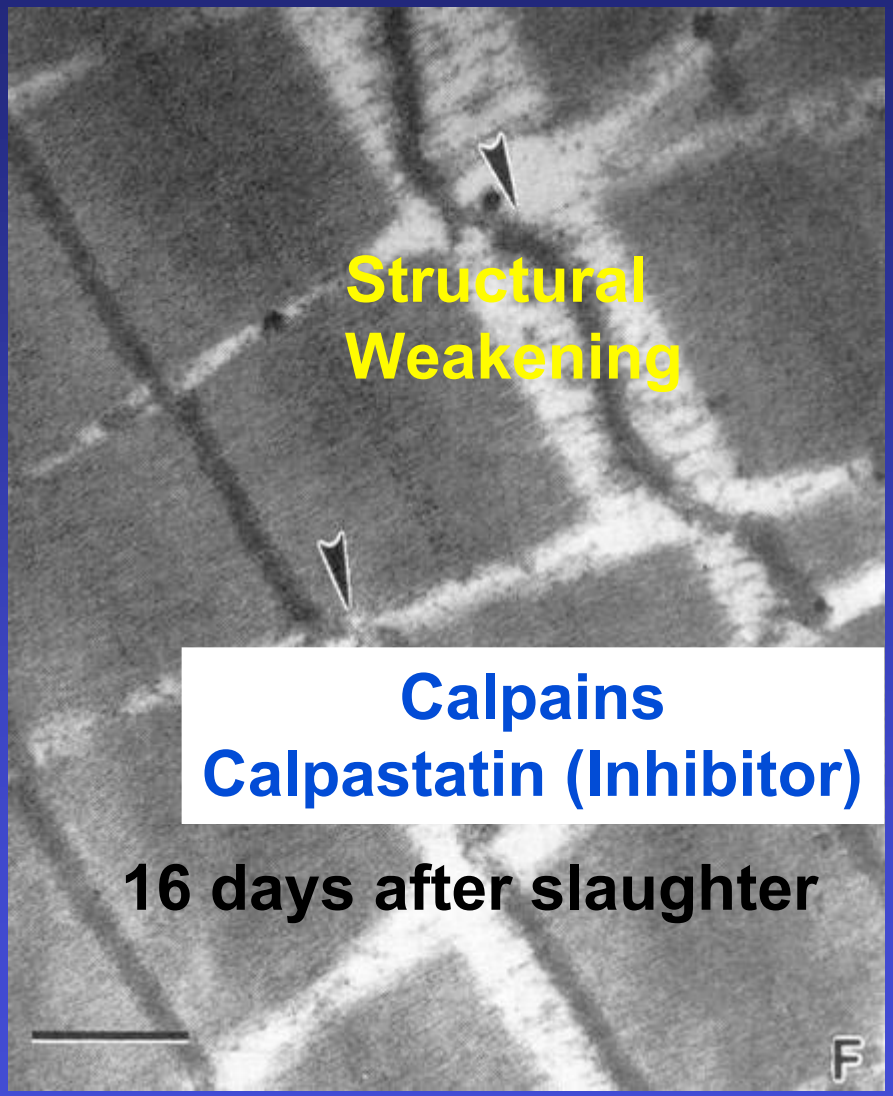
GeneSTAR Marbling Frequencies



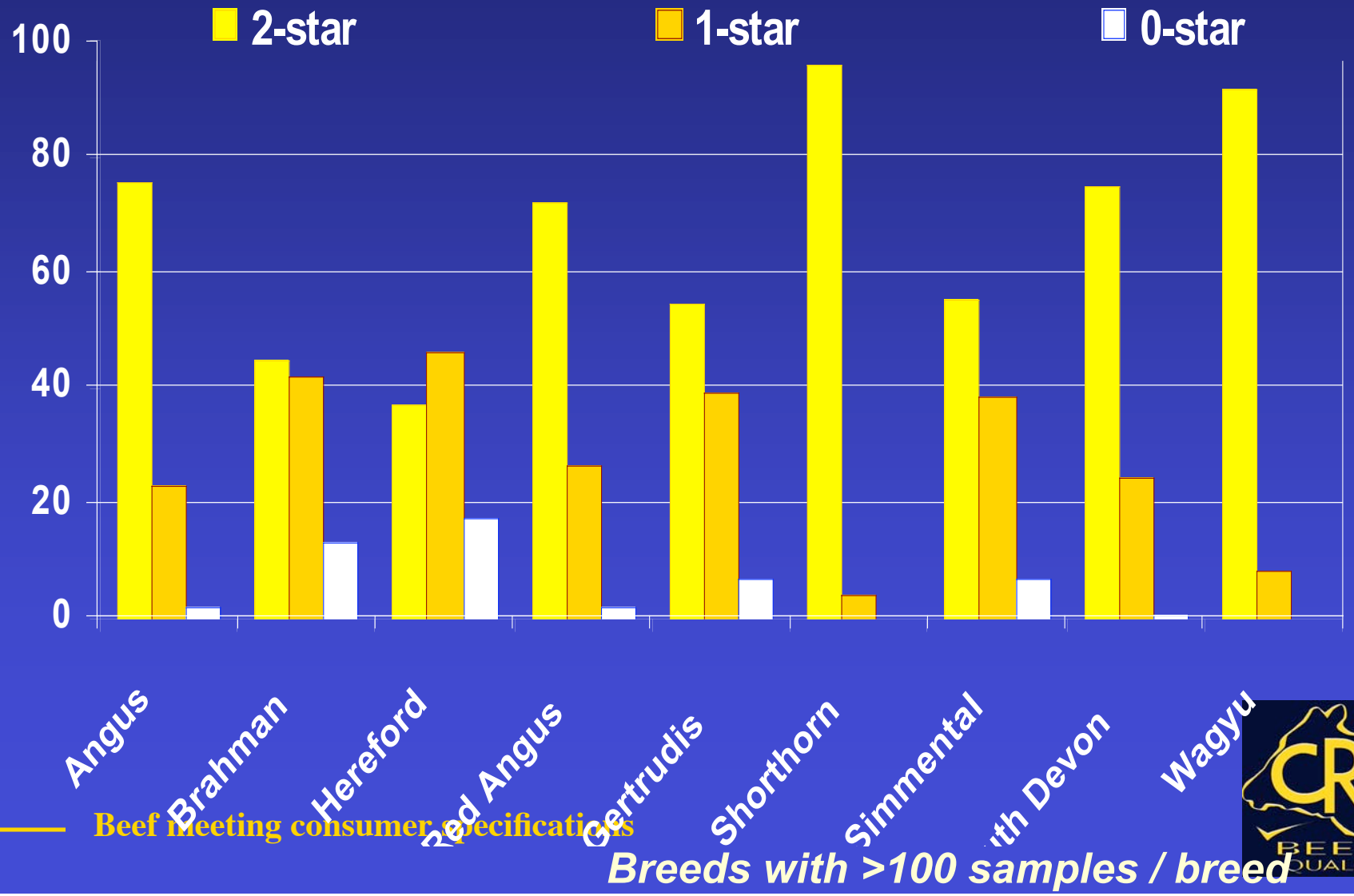
Beef meeting consumer specifications

Breeds with >100 samples / breed

Tenderisation



GeneSTAR Tenderness Frequencies



Beef meeting consumer specifications

Breeds with >100 samples / breed

CRC Outcomes

Feeding Cattle Better

- **EBVs for Net Feed Efficiency of grain-fed cattle**
- **Genetic associations for meat quality traits:**
  - ✓ Grain *vs* Grass finish
  - ✓ North *vs* South
  - ✓ Domestic *vs* Korean *vs* Japanese Markets
- **Relative contribution to Beef Quality:**
  - ❖ Genetics
  - ❖ Growth Path
  - ❖ Processing
  - ❖ Ageing
- **Nutritional manipulation of marbling**
- **Acidosis**

Beef meeting consumer specifications

CRC Outcomes

Healthier feedlot cattle:

- "Pre-boosting" to improve feedlot performance
- "Flight time" test to improve temperament & tenderness of tropically adapted cattle
- Two vaccines against Bovine Respiratory Disease:
  - ✓ *Pasteurella h.*
  - ✓ "Pestigard"
- Less antibiotics!

Beef meeting consumer specifications

CRC Outcomes

Eating quality of grain-fed beef

- Grain *vs* Grass Tenderness
- Grain *vs* Grass Marbling
- Genetic links (*r*gs) between marbling (IMF%) and
  - Tenderness
  - Eating Quality
  - RBY %
  - Other traits

Beef meeting consumer specifications

Crossbreeding Program Design

Brahman-derived
(Santa Gertrudis, Charbray)

European
(Charolais, Limousin)

Sanga-derived
(Belmont Red)

British
(Angus
Hereford
Shorthorn)

Brahman
(Purebred Control)

F_1 Progeny

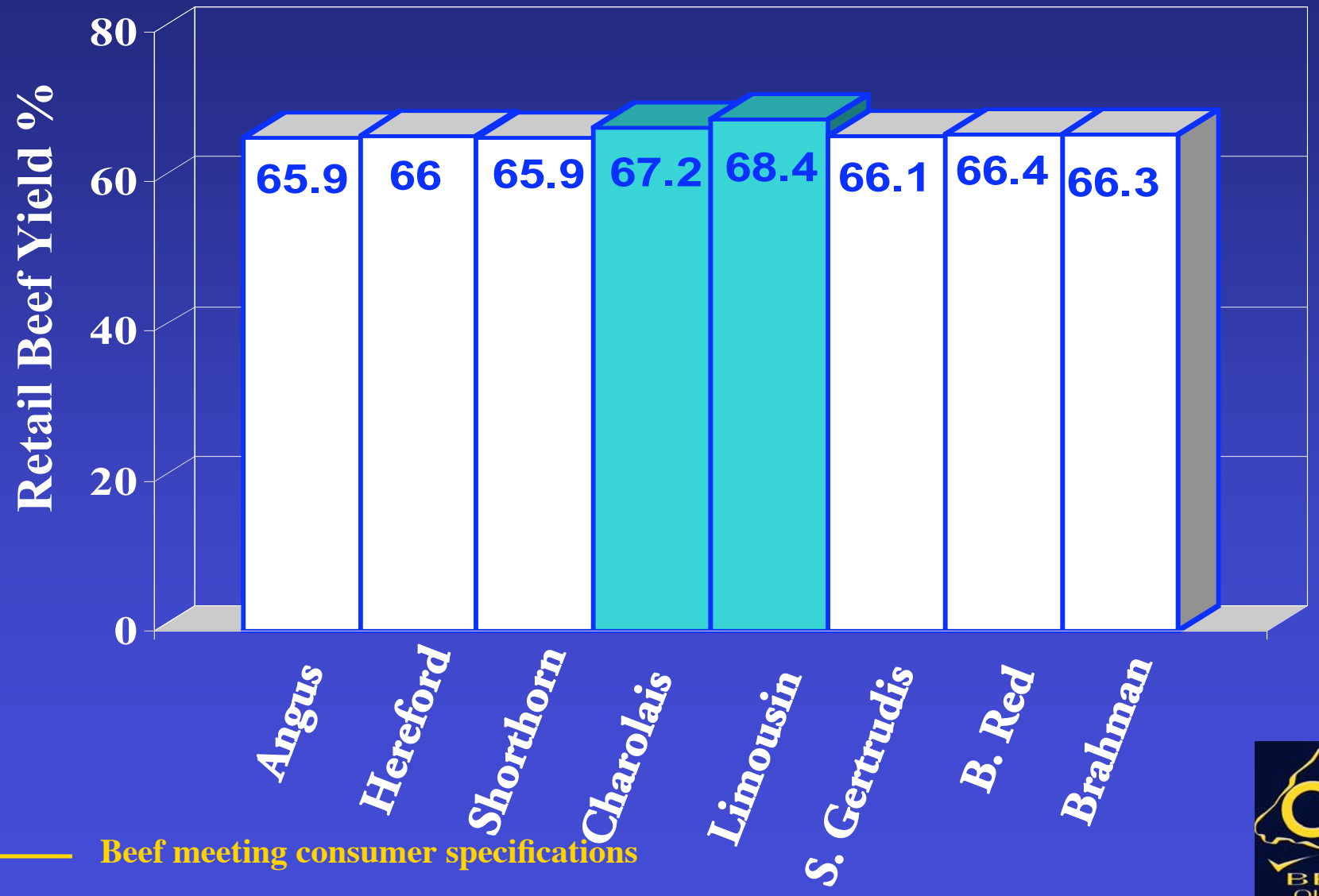
Northern feedlot

Southern feedlot

Northern pasture

Sire breed effects on retail beef yield %

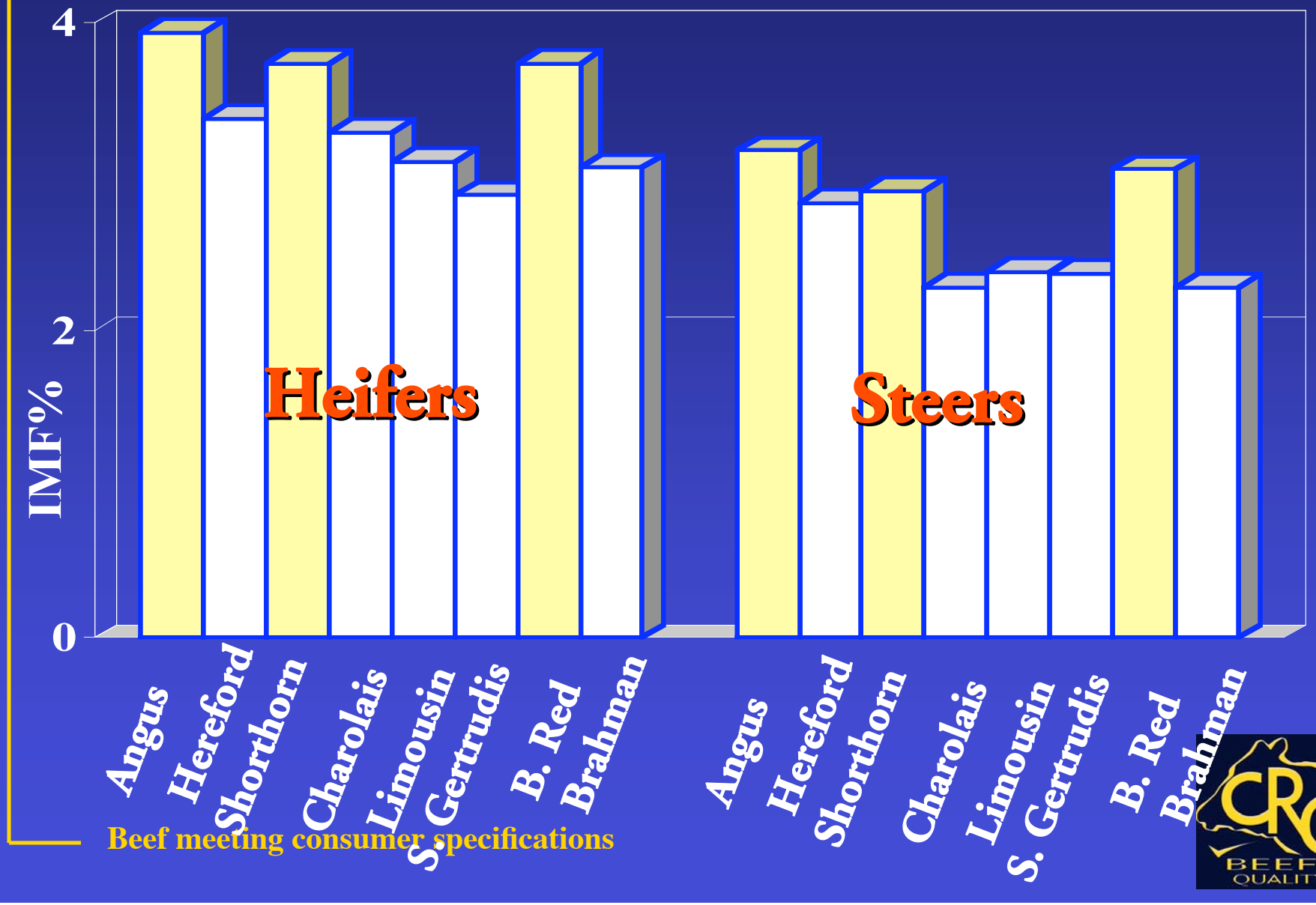
(adjusted for sire within breed and to a common carcase weight)



Beef meeting consumer specifications

CRC BEEF QUALITY

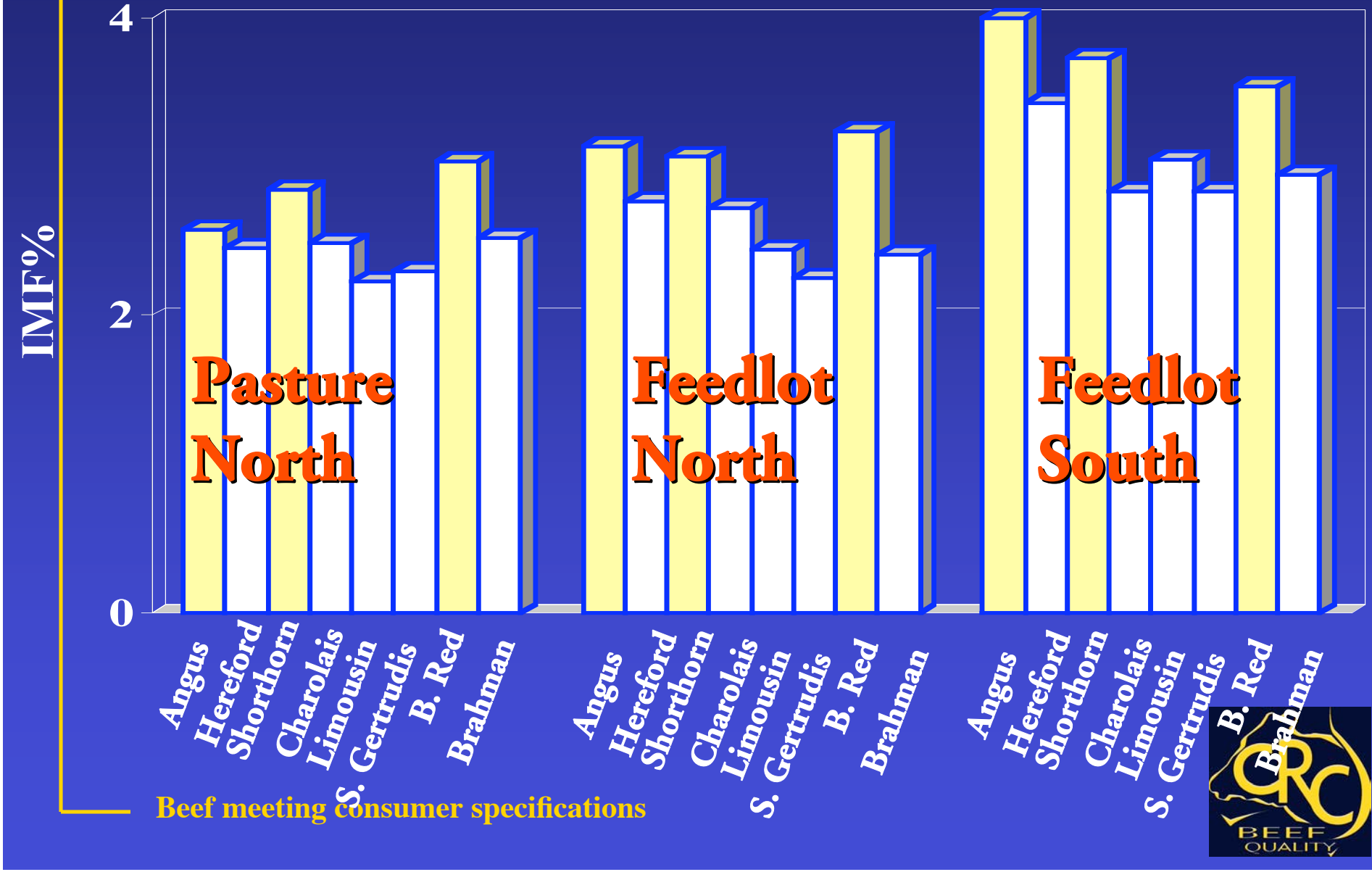
Sire breed and sex effects on IMF%



Beef meeting consumer specifications

CRC BEEF QUALITY

Sire breed and finish effects on IMF%

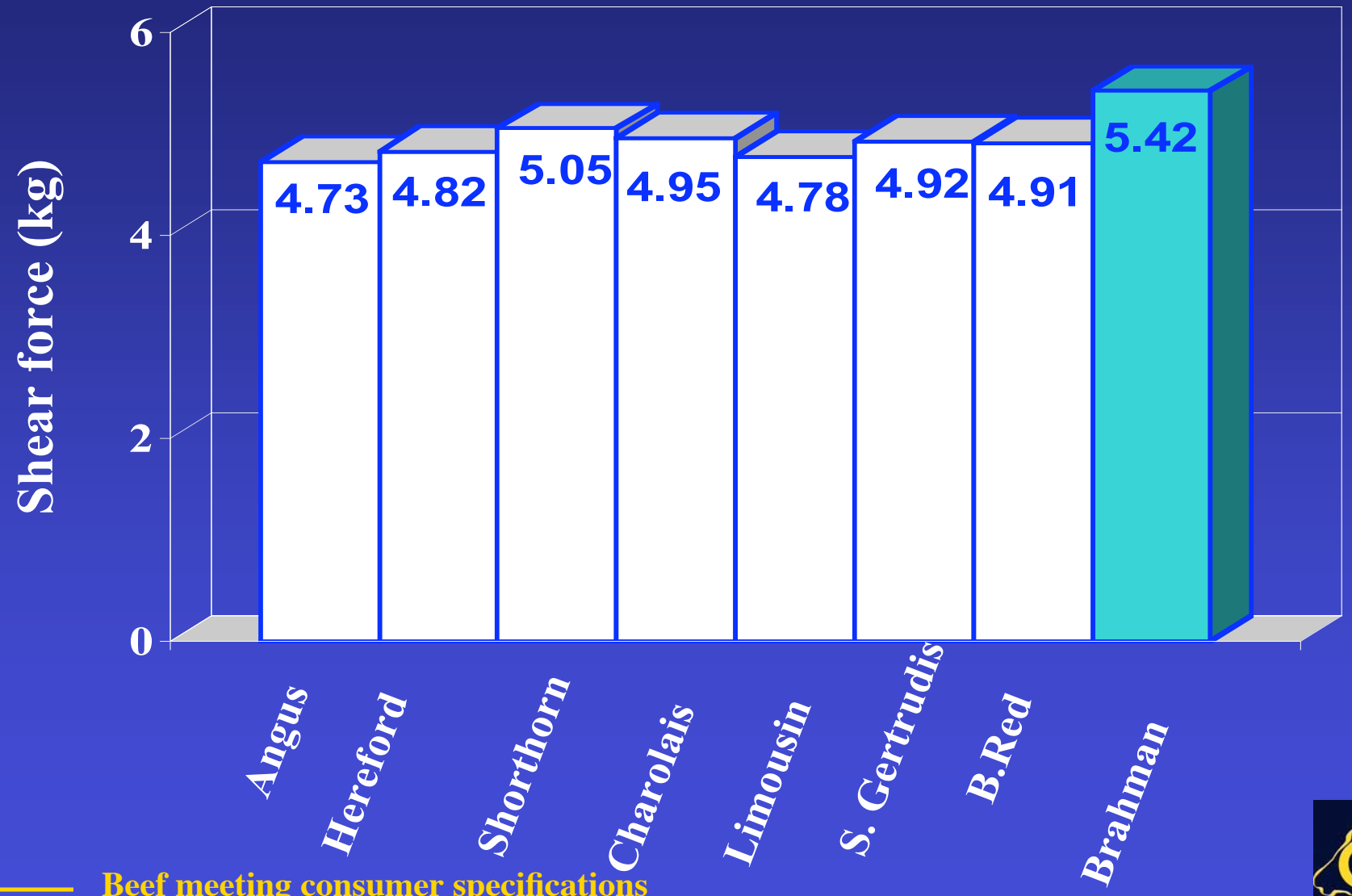


Beef meeting consumer specifications

CRC BEEF QUALITY

Sire breed effects on shear force

(>4.5 – 5 kg: generally regarded as tough)

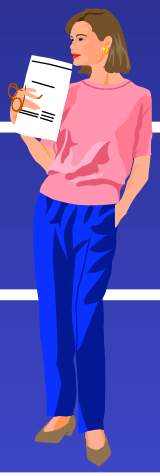


Beef meeting consumer specifications

CRC BEEF QUALITY

Eating quality measured by sensory analysis

Tenderness	0	100
Juiciness	0	100
Flavour	0	100
Overall Liking	0	100



	3 ★	4 ★	5 ★
Unsatisfactory	Good Everyday	Better than Everyday	Gourmet

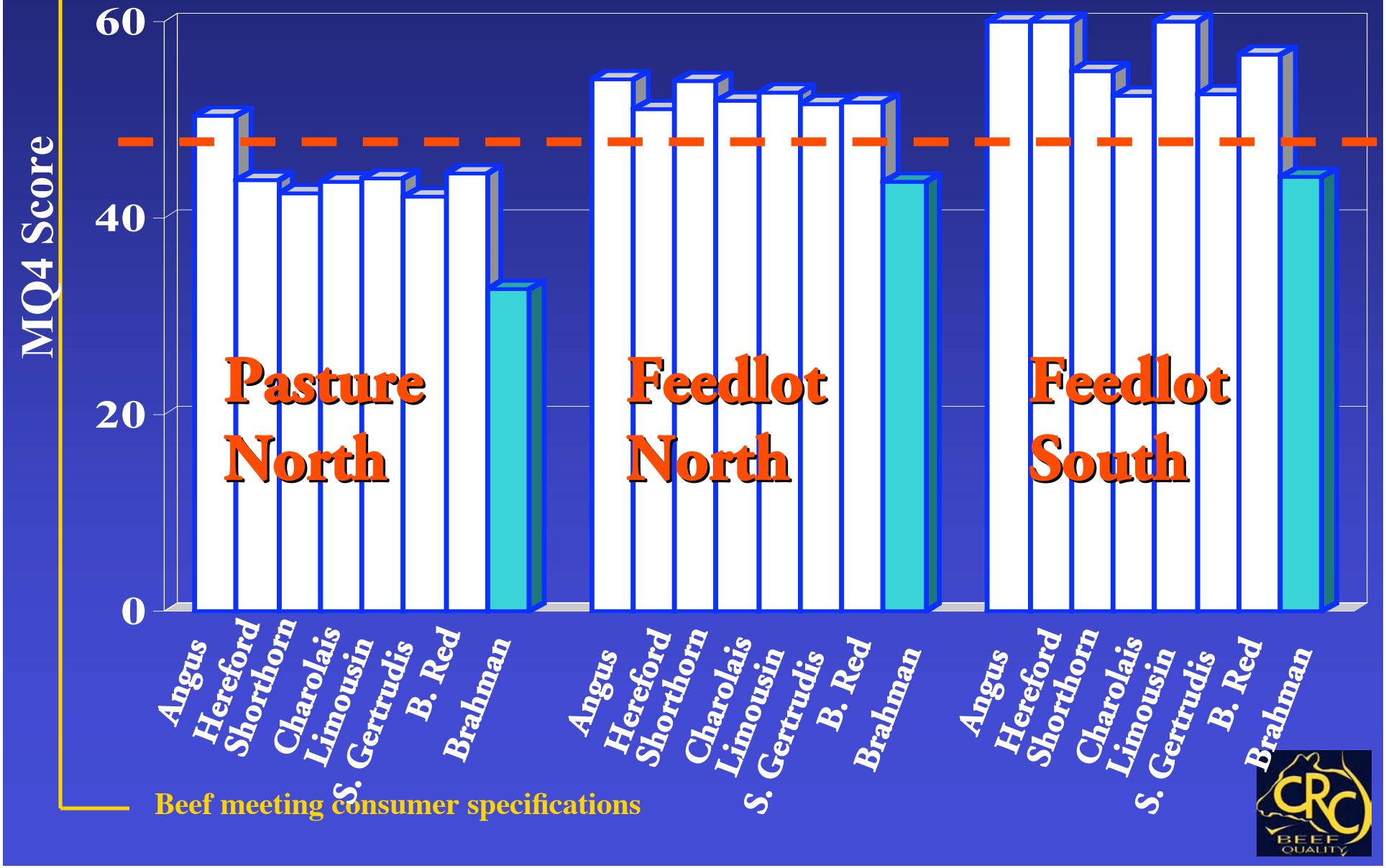
Beef meeting consumer specifications

Grading System Comparison

Trait	USDA	JGS	MSA
Genetics			α
Growth pattern			α
Pre-slaughter stress			α
Stimulation			α
Ph/temperature window			α
Hang			α
Marbling	α	α	α
Ossification	α		α
Texture	α	α	
Meat Colour	α	α	α
Ultimate ph			α
Cut			α
Ageing			α
Cooking			α

Beef meeting consumer specifications

Sire breed and finish effects on MQ4



BRAHMAN

Stanbroke **Belmont** **Consolidated** **Tartrus** **Cona Ck**

Link sires | Link sires | Link sires

53 sires

Steers

n = 1035

"Kiagarthur"	"Tullimba"	"Crescendo"	"Brigalow"	"Berrigurra"
Condobolin	Armidale	Dysart	Theodore	Blackwater

FEEDLOT "Tullimba"

Slaughter

Heifers

n = 1045

"Toorak"	"Belmont"	"Swans Lagoon"
Julia Creek	Rock-hampton	Ayr

Grown out, mated for (3) years

progeny

Males retained fertility

Females Sold

Tropical COMPOSITE

NAPCo **AACo** **Belmont** **Mandalay**

Link sires Link sires Link sires

52 sires

Steers

n = 1225

"Kiagarthur"	"Tullimba"	"Crescendo"	"Brigalow"	"Berrigurra"
Condobolin	Armidale	Dysart	Theodore	Blackwater

FEEDLOT "Tullimba"

Slaughter

Heifers

n = 1140

"Toorak"	"Brian Pastures"	"Belmont"
Julia Creek	Gayndah	Rock-hampton

Grown out, mated for (3) years

progeny

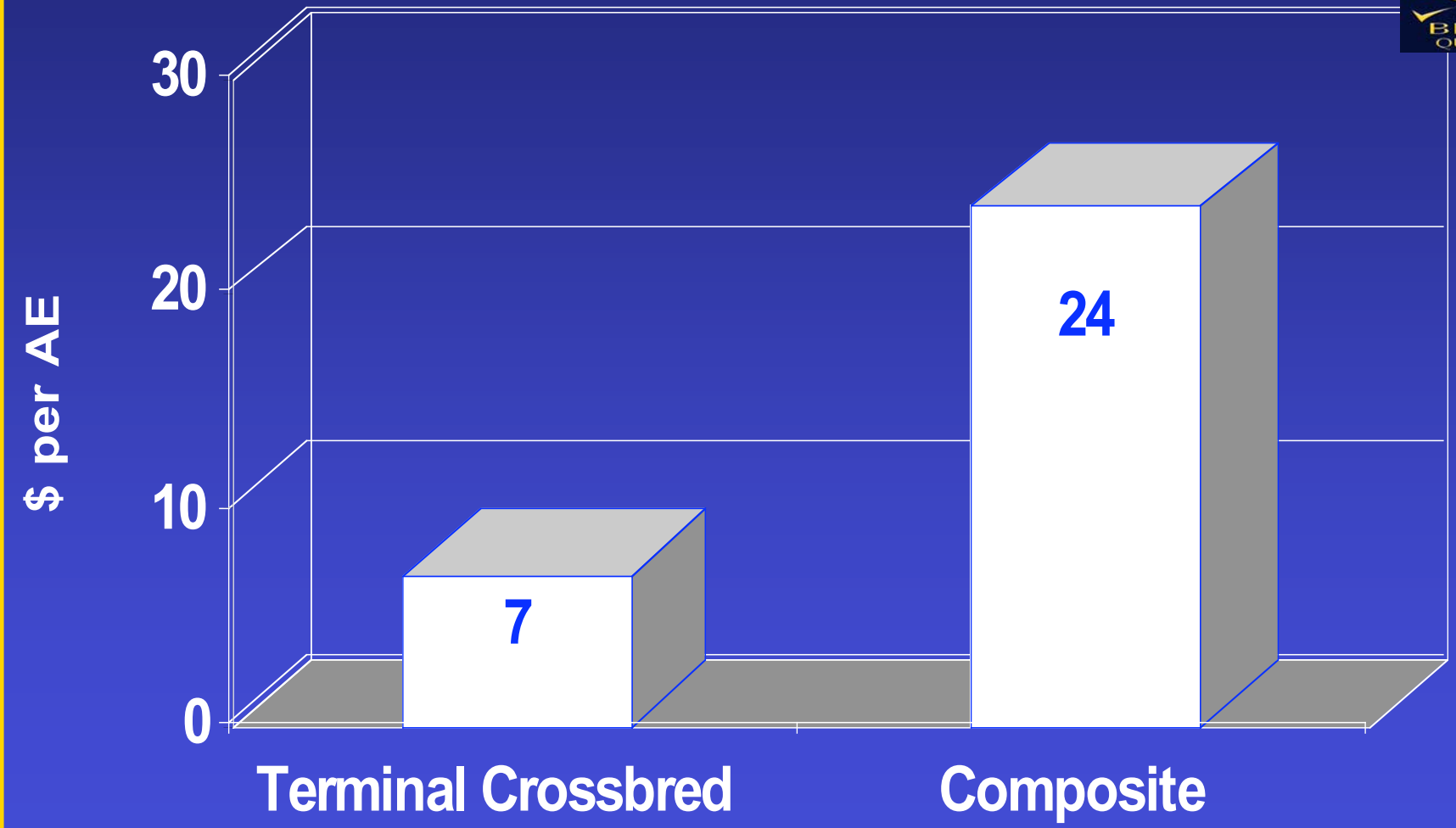
Males retained fertility

Females Sold

Value of improving Carcase and Beef Quality by Crossbreeding

Increased Gross Margin per AE

(individual herd, grass-finished, relative to Brahman)



Beef meeting consumer specifications

Extra Gross Margin for Grain Finishing

(crossbred and composite relative to Brahman)

5c/kg tenderness premium on 60% of fed steers

10c/kg marbling premium on 15% of fed steers

Growth rate and feed efficiency differences

Extra gross margin = $52 per AE

+ $7 and $24 for base model

Feed efficiency of growing cattle

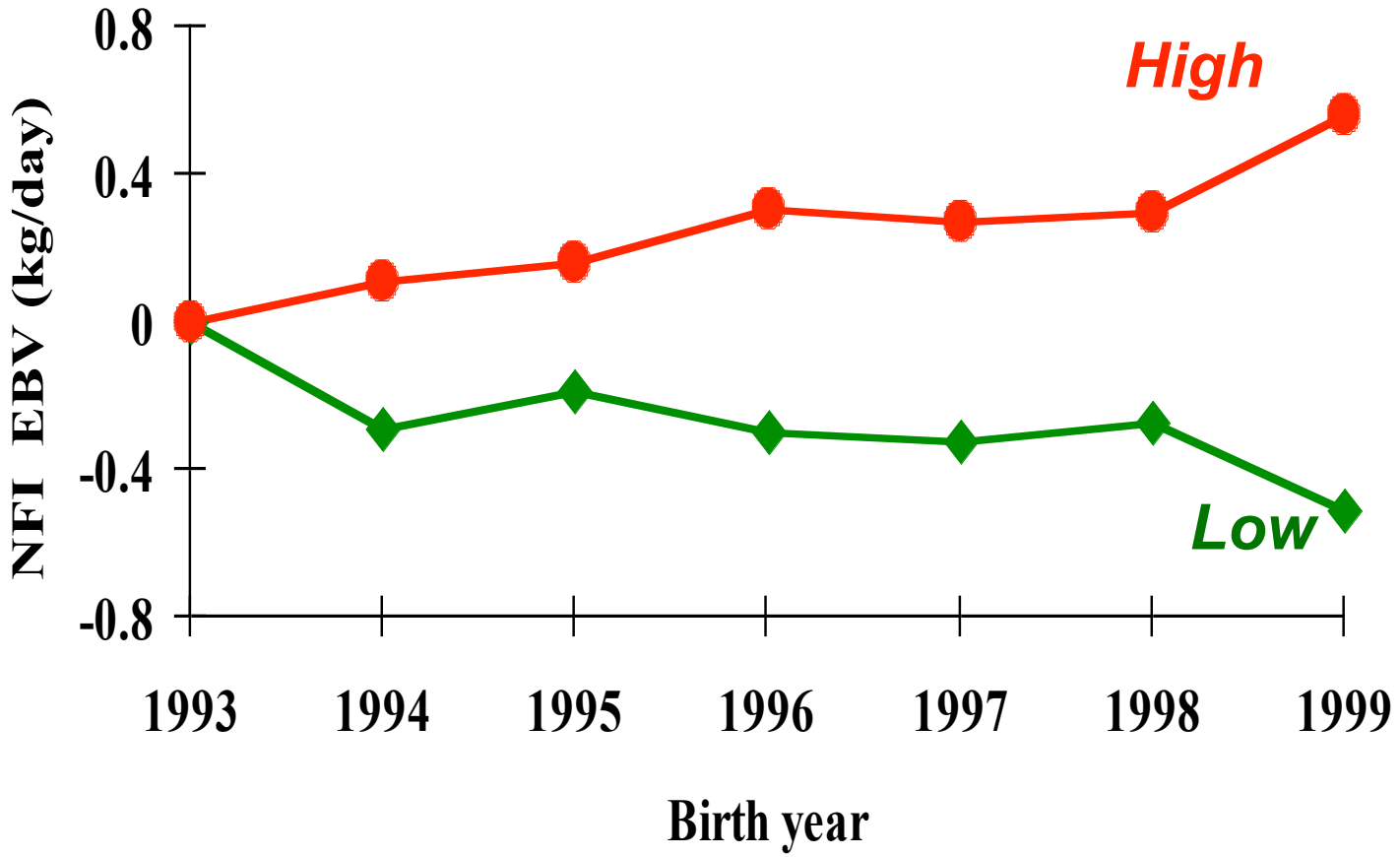
- **Net feed intake (NFI) adopted for genetic improvement of feed efficiency**
- **Within-breed genetic variation in NFI**
- **NFI has a moderate heritability**
  - **38% in Trangie Angus bulls and heifers**
  - **18% CRC1 steers and heifers**
  - **24% and 38% in CRC2 Brahman and Tropical Composite steers.**

Feed efficiency of growing cattle

- **Between breed genetic variation in NFI**
  - **CRC1 crossbreeding experiment**
  - **CRC2 Brahman and Tropical Composite expt.**
- **Lower NFI associated with lower feed intake, improved FCR and with leanness (r_g .06 to .7).**

Responds to selection

Trangie NFI selection lines



Selection for low NFI

produces steers:

- **no reduction in intake, better growth and more efficient on pasture**
- **similar growth with less feed in the feedlot**
- **no compromise in carcase traits.**

Beef meeting consumer specifications

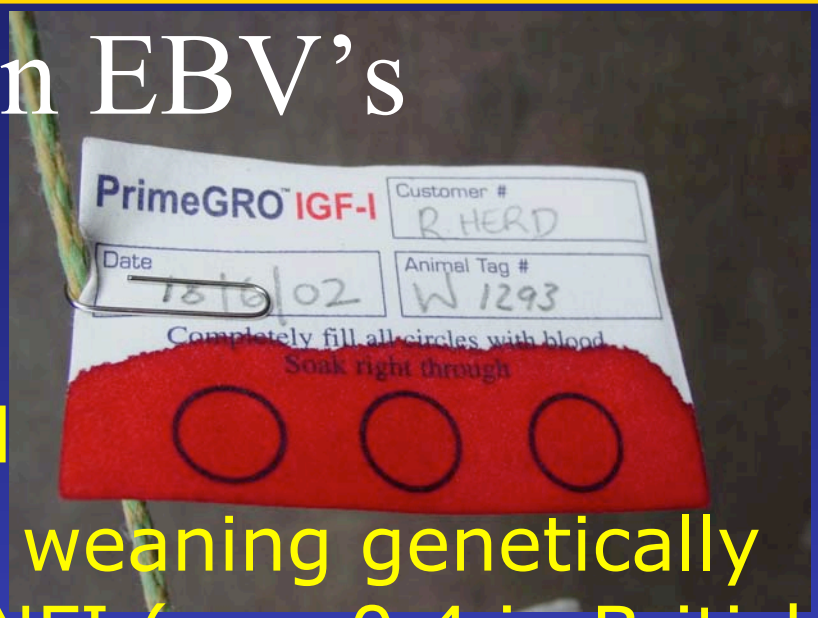
Greenhouse gas benefit

Reduction in methane emissions accompanies reduction in feed intake and NFI.

NFI EBV

- Used to describe genetic merit for feed efficiency
- In Angus and Herefords uses feed intake data and IGF-I data
- Top and bottom published sires differ by 1.61 kg/day in Angus and by 1.09 kg/day in Hereford.

Using IGF-I in EBV's



- Protein in blood
- IGF-I before/at weaning genetically correlated with NFI (r_g = 0.4 in British breeds)
- Also likely genetic associations with other important traits eg. fatness, yield, fertility
- Current postweaning measurement not associated with NFI in Tropically-adapted breeds.

What about cow traits?

If we select for feed efficiency based on young bull, steer or heifer traits what do we change in cow traits

- ⇨ **CRC2 Brahman and Tropical Composite experiment**
- ⇨ **Trangie feed efficiency project.**

What about cow traits?

- Trangie feedlot NFI tests of non-pregnant, non-lactating Angus cows
- Genetic variation, NFI heritability 22%
- Superior NFI correlated with lower feed intake
- Trend towards leanness (r_g .09).

Cow reproduction

- No difference in percent of cows pregnant, calving or weaning a calf, between Trangie low and high NFI selection lines
- Trend to later days-to-calving in low NFI line
- Evidence in Angus breed of negative (unfavourable) correlation between days-to-calving with NFI

⇨ Genetic association needs to be known

Summary for feed efficiency

- **Genetic basis of feed efficiency**
  - heritable, breed differences exist
    - responds to selection
  - tools to find feed efficient cattle (NFI EBV)
  - opportunity to reduce feed cost of production
- **Known associations with other traits eg. IGF-I**
- **Also not so well known associations eg. with cow productivity**
- ☞ **EBV available, not for single trait selection.**