Disruptive measurement technologies!

Graham Gardner

Outline

- Carcase measurement – the status quo
- Project to accelerate development
  - Beef and lamb industries
- Detail progress for some technologies

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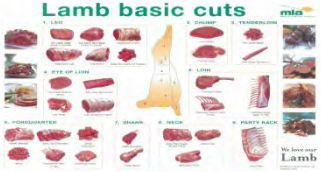
Precision measurement
from paddock/pen to plate

- Predict quality and amount of final product

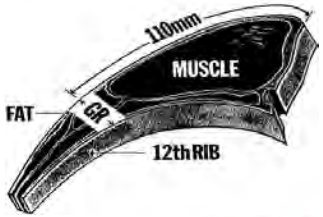


Conception — Value — Live Animal — Value — Carcase — Value — Retail Cuts — Value — Cooked Product

Australian Lamb Market

- Lamb traded largely on carcase weight

- Fat penalties only at the extremes
    - 5mm < GR tissue depth < 20mm



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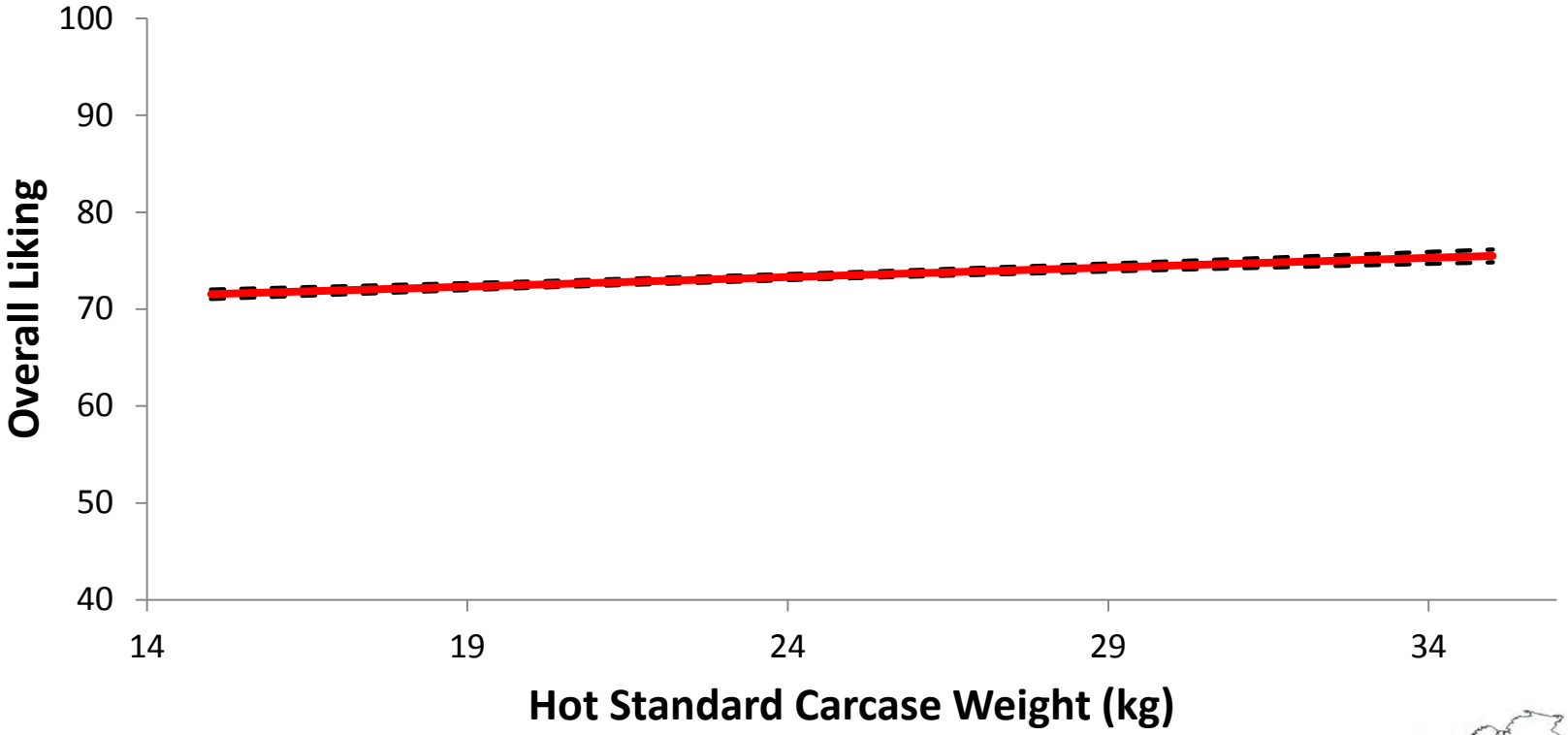
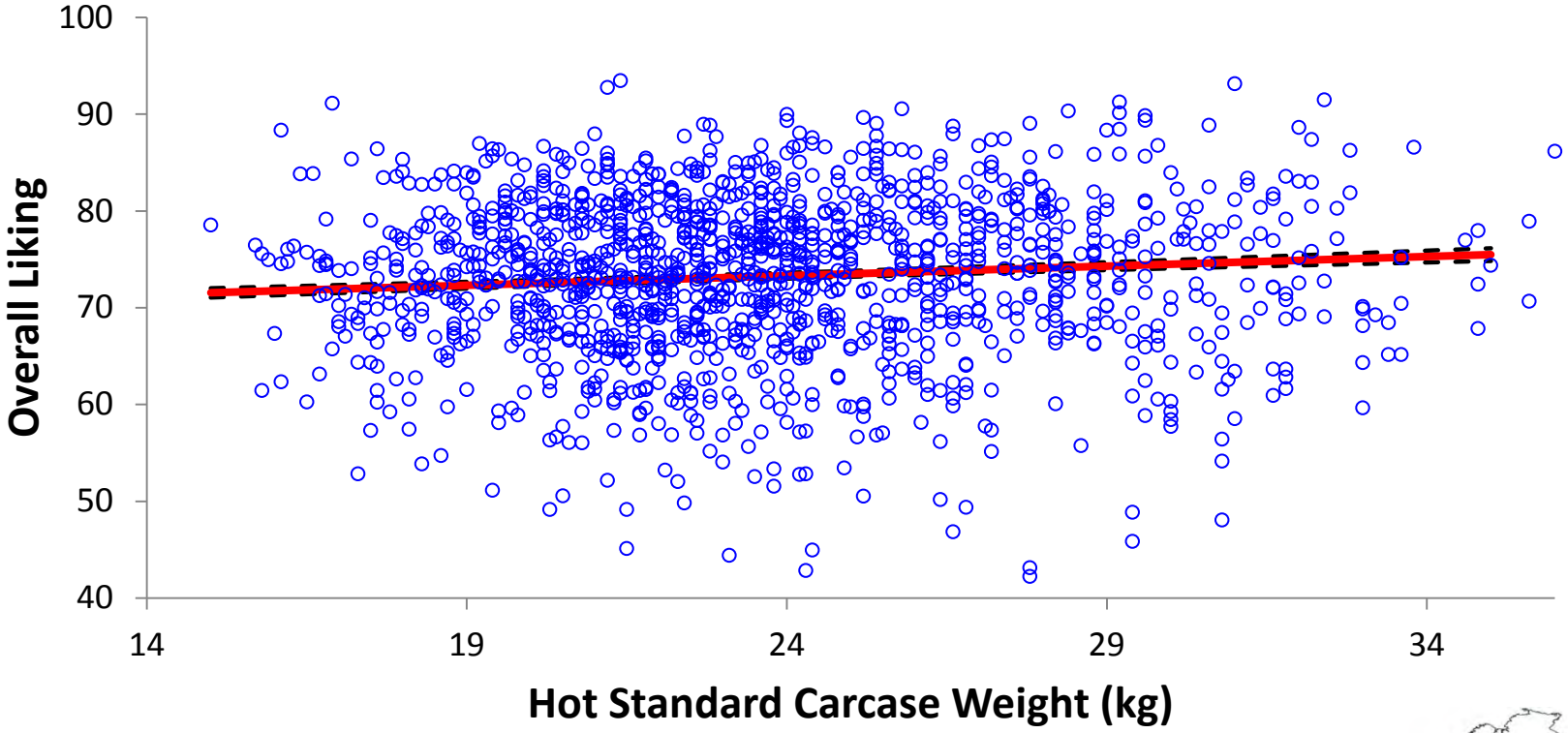
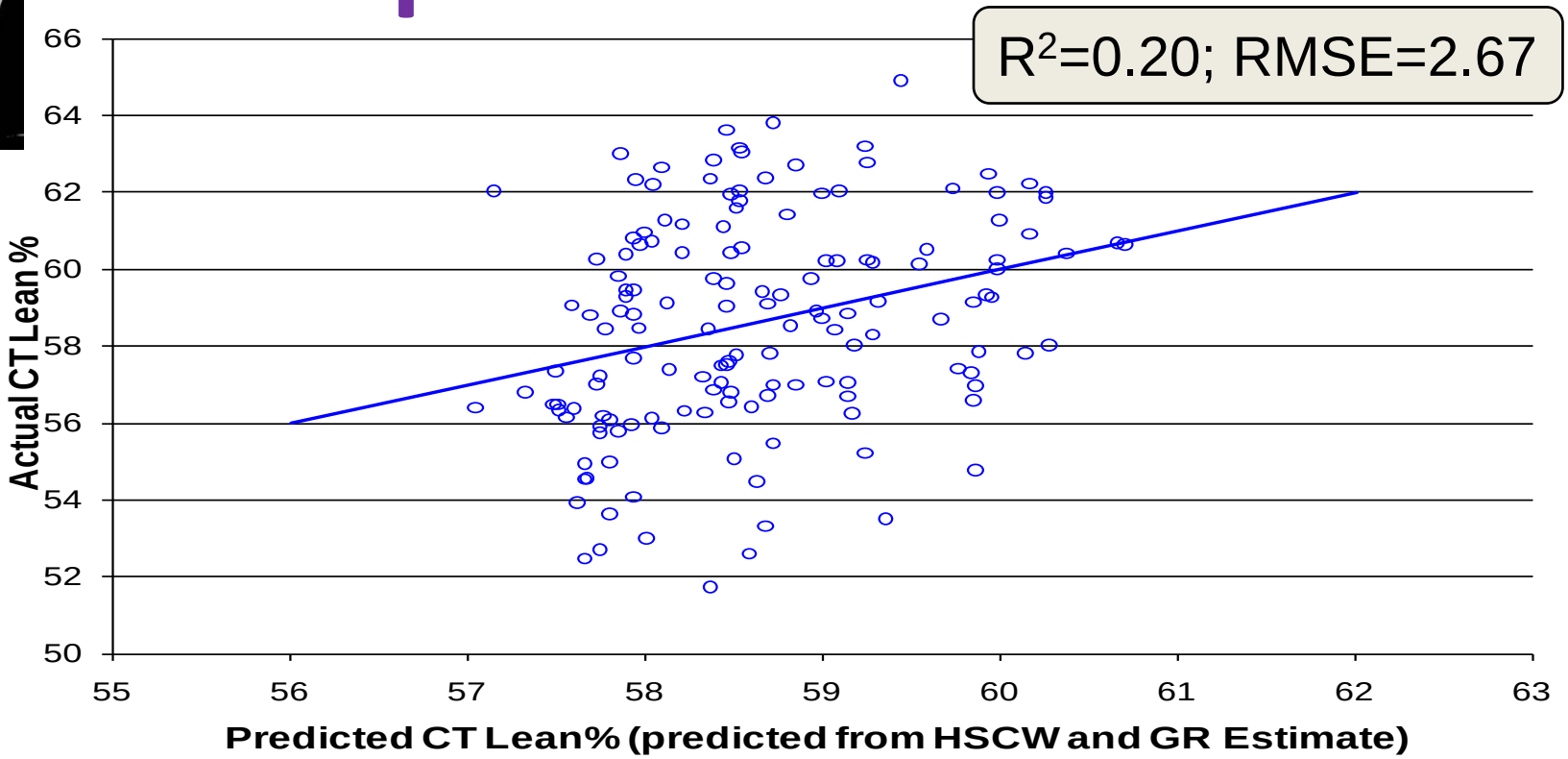
Loin Eating Quality and HSCW



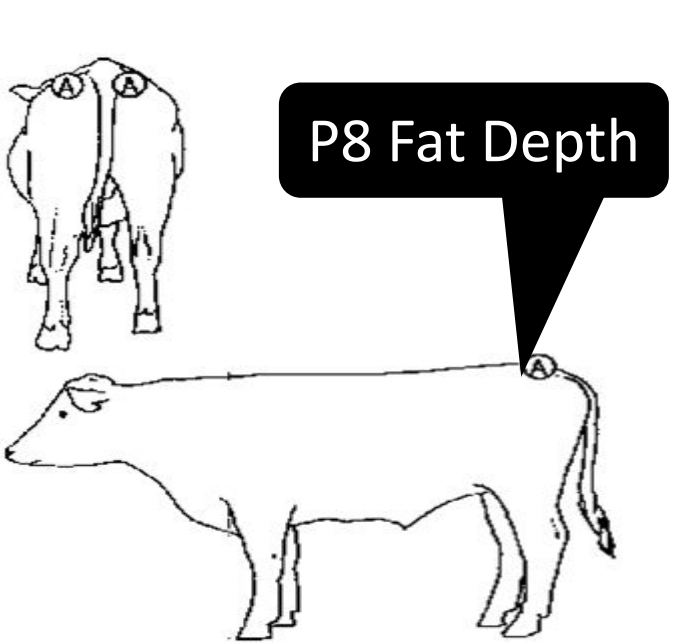
Loin Eating Quality and HSCW



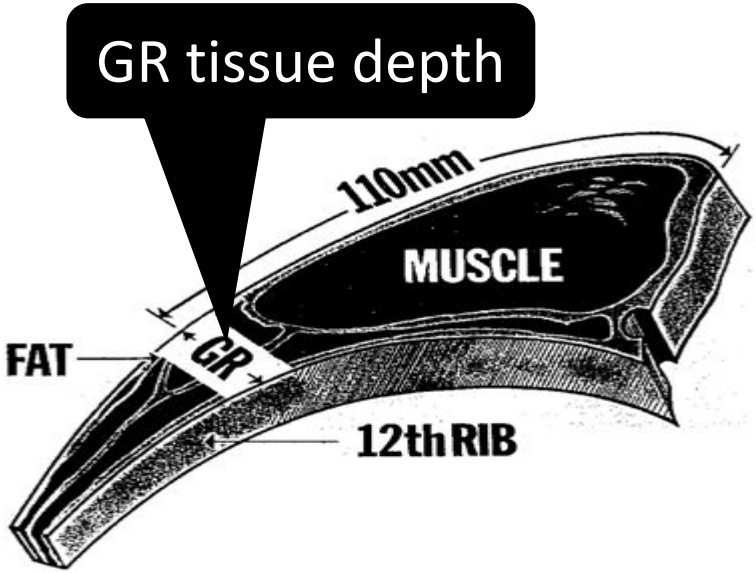
Palpated GR and HSCW



Beef isn't much better…



Cattle



Sheep

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Industry feedback - MSA

Meat Standards Australia eating quality model

Description	Format	Name	Input	?
Estimated % Bos Indicus	% or X if doubt	EPBI	0	
Animal Sex Type	M/F	Sex	F	
mone Growth Promotent	Y or ? / N	HGP	n	
MilkFedVealer	Y/N	MFV	n	
SaleYard	Y/N	SlYrd	n	
Rinse/Flush	Y/N	RnFl	n	
Hot Std Carcase Weight	Weight in Kg	HSCW	350	
HangMethod	T/TS/TL/TC/XT	Hang	at	
Hump Height	mm	Hump	63	
Ossification USDA	USDA measure	uoss	290	
Marbling USDA	USDA measure	umb	300	
RibFat	mm	RbFt	10	
Ulitimate pH	Metered pH	UpH	5.5	
Loin Temp at Grade	Metered Temp C	Utmp	9	
Days of Ageing from Kill	Days Aged	Age	5	

Aged

cut	muscle	GRL	RST	SFR	TSL	SCT	CRN
spinalis	SPN081	79	69	79	75		
tenderloin	TDR034	82		76			
tenderloin	TDR062	78	77	80	74		
tenderloin	TDR063	73					
cube roll	CUB045	62	62	62	64		
striploin	STA045	55	56	58	58		
striploin	STP045	53	54	57	57		
oyster blade	OYS036	67	64	69	72		
blade	BLD095			43			
blade	BLD096	53	57	58	59	59	
chucktender	CTR085		49	51	53	59	
rump	RMP131	51	59	56	62	54	
rump	RMP231	54	62	61	60		
rump	RMP005	59		67	67		
rump	RMP032			64	68		
rump	RMP087		52	57	55	56	
knuckle	KNU066	46	59	54	58	47	
knuckle	KNU098			54	59	56	
knuckle	KNU099	36	47	44	51	52	
knuckle	KNU100			60	62	55	
outside flat	OUT005		40	43	56	59	52
outside flat	OUT029			54	61	55	
eye round	EYE075	40	44	42	45	46	45
topside	TOP001	39		51	53	50	
topside	TOP033	40		53	58	60	
topside	TOP073	34	43	43	56	52	
chuck	CHK068			48	53	65	
chuck	CHK074	63	56	61	67	72	
chuck	CHK078	56	57	58	62	69	
chuck	CHK081			60	64	75	
chuck	CHK082			52	56		
thin-flank	TFL051			58		58	
thin-flank	TFL052			67	59	64	
thin-flank	TFL064			61	58	60	
rib-blade	RIB041			48			
brisket	BRI056			44	58	60	38
brisket	BRI057			41	49	64	
shin	FQshin					57	
shin	HQshin					60	
intercostal	INT037			57			

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Variability in these traits has a cost!

- Lean meat yield
  - More fat trimmed (labour/waste)
  - Inconsistent retail cut size
- Eating quality
  - Consumer confidence

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Variability in these traits has a cost!

- Variability can be managed with…
  - carcase sorting (prior to fabrication)
  - cut sorting for cut size and EQ

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Variability in these traits has a cost!

- Variability can be managed with…
  - carcase sorting (prior to fabrication)
  - cut sorting for cut size and EQ

If we can measure it!

We need measurement technologies!

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Australian Government
Department of Agriculture and Water Resources

Rural Research and Development for Profit Programme
Keeping Australian farmers at the cutting edge

Advanced Livestock Measurement Technologies

This project is supported by funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit programme in partnership with Research & Development Corporations, commercial companies, state departments and universities

AMPC

AUSTRALIAN Pork

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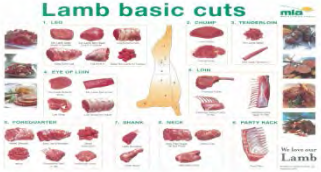
Precision measurement
from paddock/pen to plate

- Predict quality and amount of final product



Conception | Live Animal | Carcase | Retail Cuts | Cooked Product

Value | **Value** | **Value** | **Value**

LMY:

3D Imaging

DEXA

GR Probe

Eating Quality:

Hyperspectral

NitFom

Synergy with Automation

Precision measurement
from paddock/pen to plate

- Predict quality and amount of final product

Conception — Value — Live Animal — Value — Carcase — Value — Retail Cuts — Value — Cooked Product

New Breeding Values

Systems to improve compliance

Price Grid

Enhanced Beef MSA

Benchmarking systems

Cut wt prediction systems

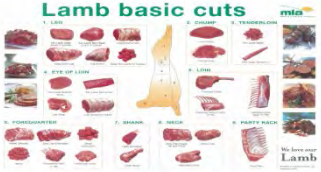
Enhanced Producer Feedback

Cuts-based Lamb MSA

Profit functions to optimise carcase use $

Precision measurement
from paddock/pen to plate

- Predict quality and amount of final product



Conception — Live Animal — Carcase — Retail Cuts — Cooked Product

Value — Value — Value — Value

Key focus:
value return to producers!

Australian Government
Department of Agriculture and Water Resources

Rural Research and Development for Profit Programme
Keeping Australian farmers at the cutting edge

Prioritising Techs for investment

Measurement tech. priorities

- Earlier the better!

Conception → Live Animal → Carcase → Retail Cuts → Cooked Product

Measurement tech. priorities

- Earlier the better!

Conception → Live Animal → Carcase → Retail Cuts → Cooked Product

  - Ease of implementation/speed
  - Precision/accuracy
  - Cost vs benefit

Measurement tech. priorities

$$$ Return per lamb is less!

Lean Meat Yield

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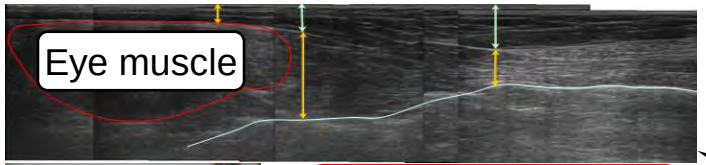
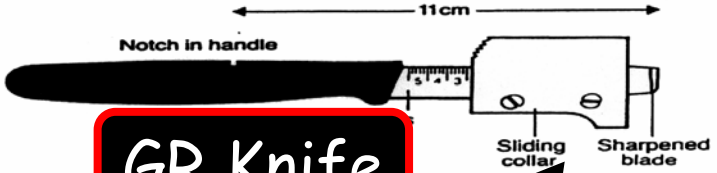
Point measures for prediction

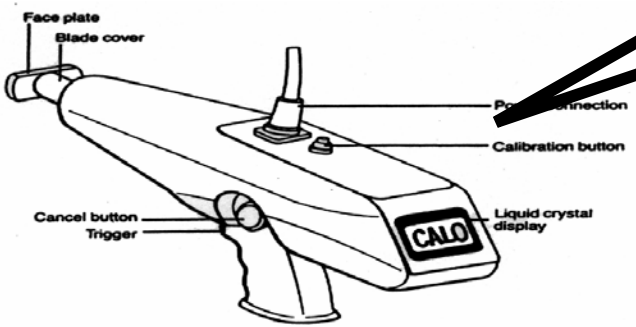


Ultrasound



GR Knife

Devices for yield measurement



Sheep Probe

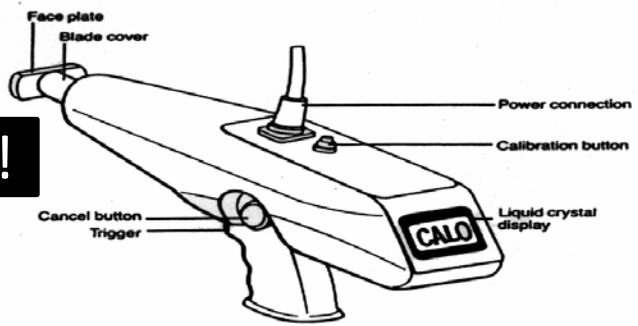
Hyperspectral Camera

Redistribution of muscle

+ 5%

- 5%

Measured here!



+8%

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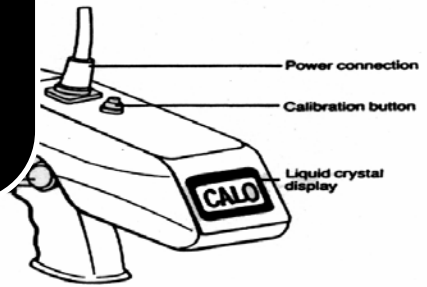
Redistribution of muscle

Biased!

+ 5%

- 5%

+8%



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Need to move towards systems that measure whole carcase lean!

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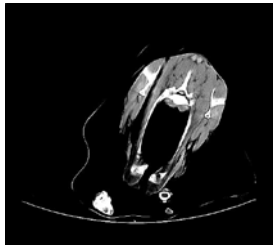
Whole carcase LMY technologies

Computed Tomography



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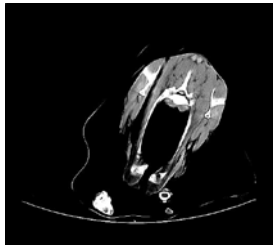
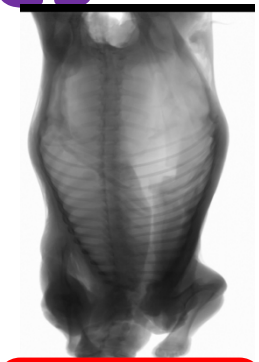
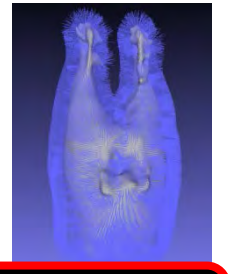
Whole carcase LMY technologies

Computed Tomography





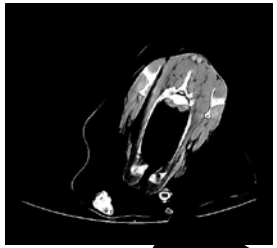
DEXA



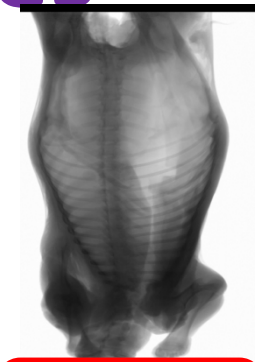
3D imaging

Whole carcase LMY technologies

Computed Tomography

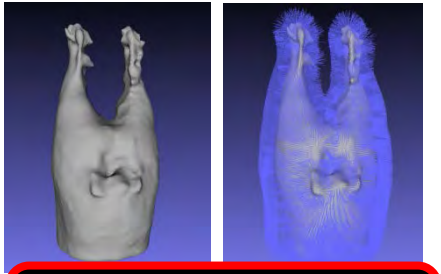


Calibrate



DEXA

Calibrate



3D imaging

DEXA

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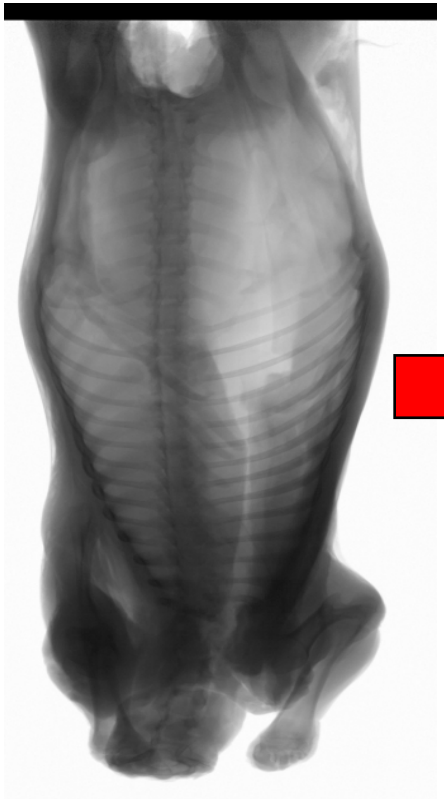
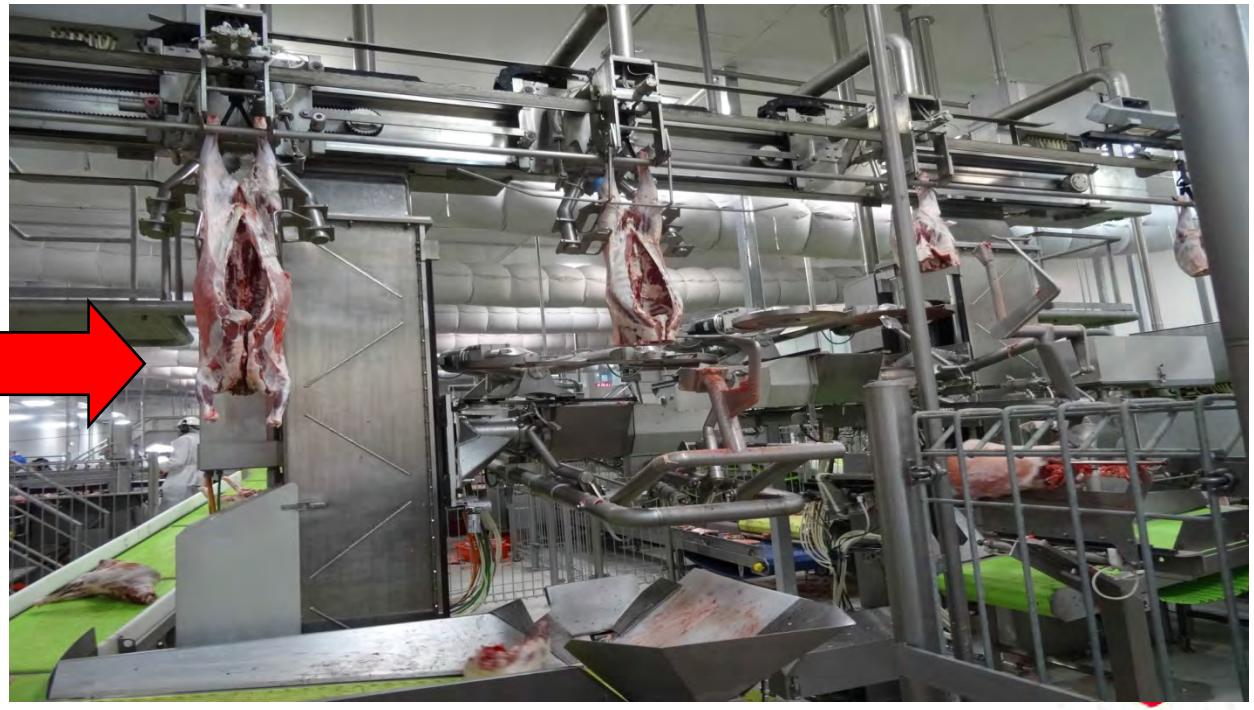
2D X-Ray for driving robots

Scott Technology





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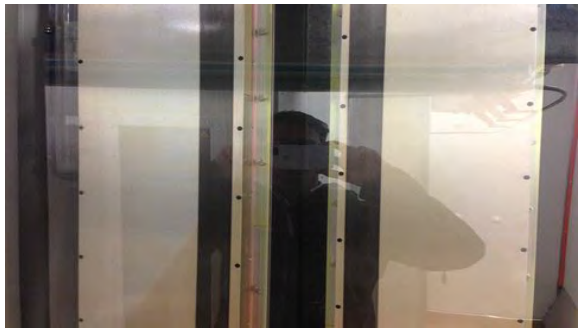
Adapt existing 2D Xray hardware



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Dual Energy Images

Low Energy Image

High Energy Image

$$R\ value = \ln(I/I_0)_{LowEnergy} / \ln(I/I_0)_{HighEnergy}$$

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Calibration

To drive industry adoption of yield measurement and payment

1 Kirby Nucleus Flock

600 lambs

Agistment, SA

Hyperspectral

DEXA

400 lambs (24kg)

JBS Bordertown, SA

100 lambs (24kg)

100 lambs (29kg)

CT Scanning

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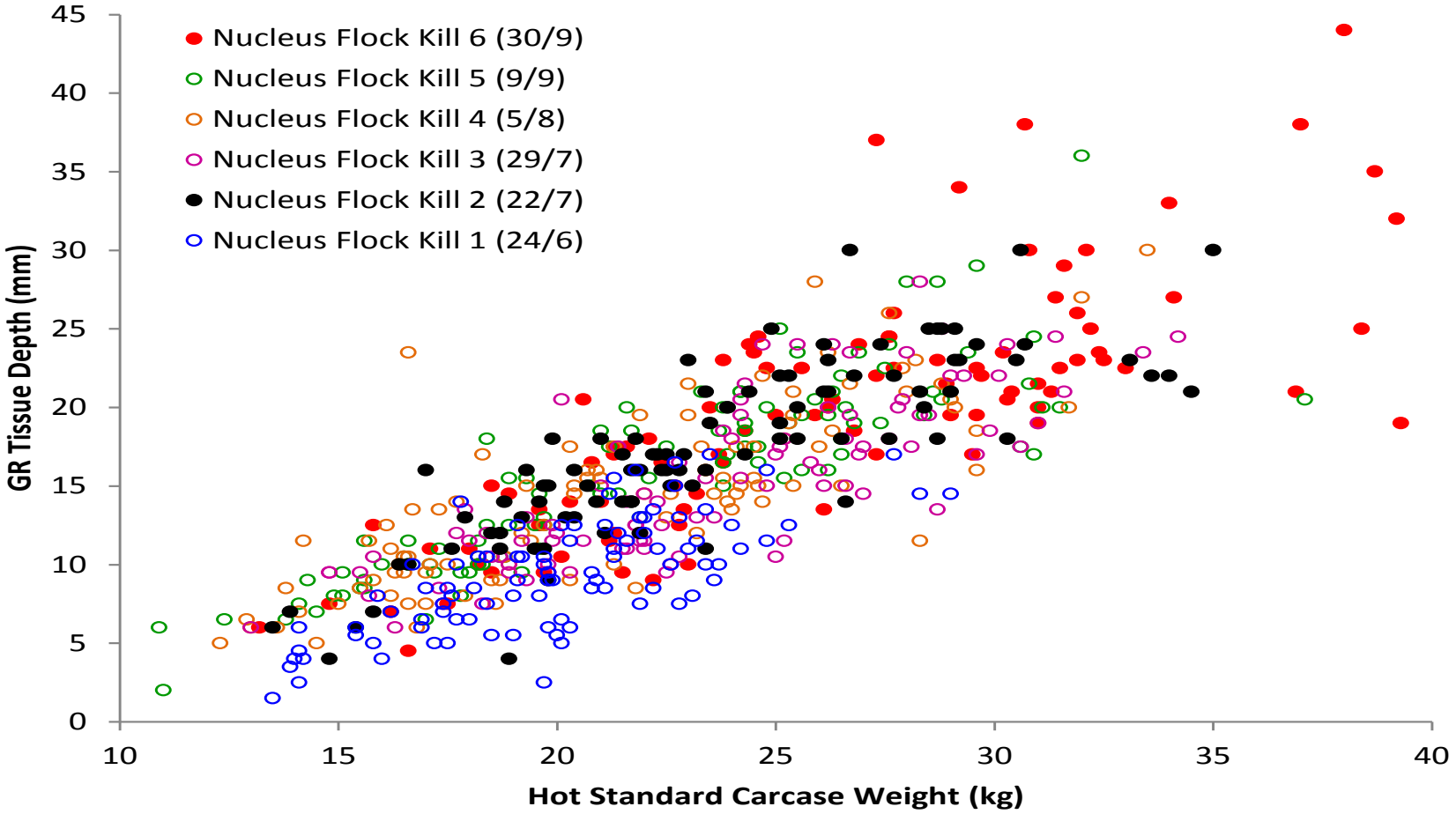
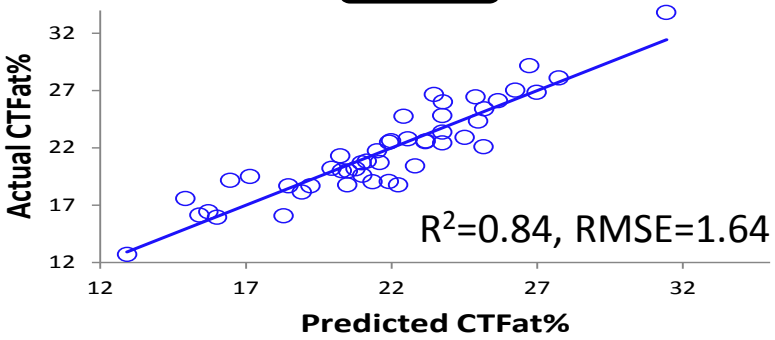
Nucleus Flock/DEXA

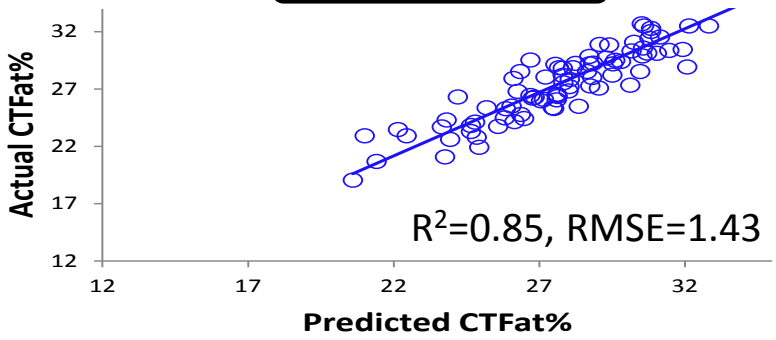


Predicting CT Fat%

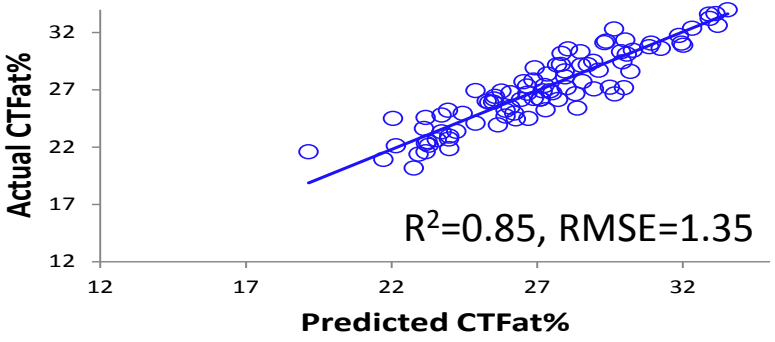
First Test



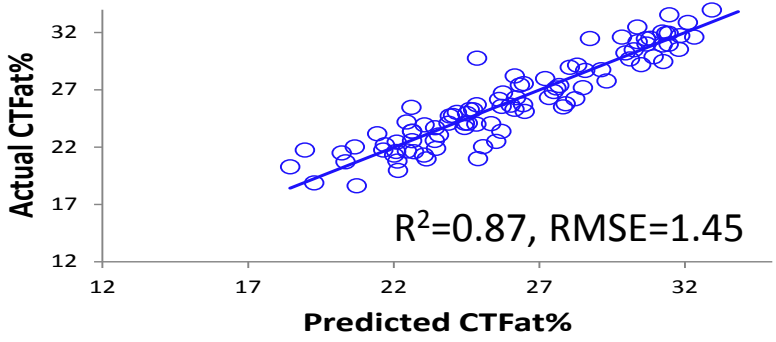
Nucleus Flock kill 1



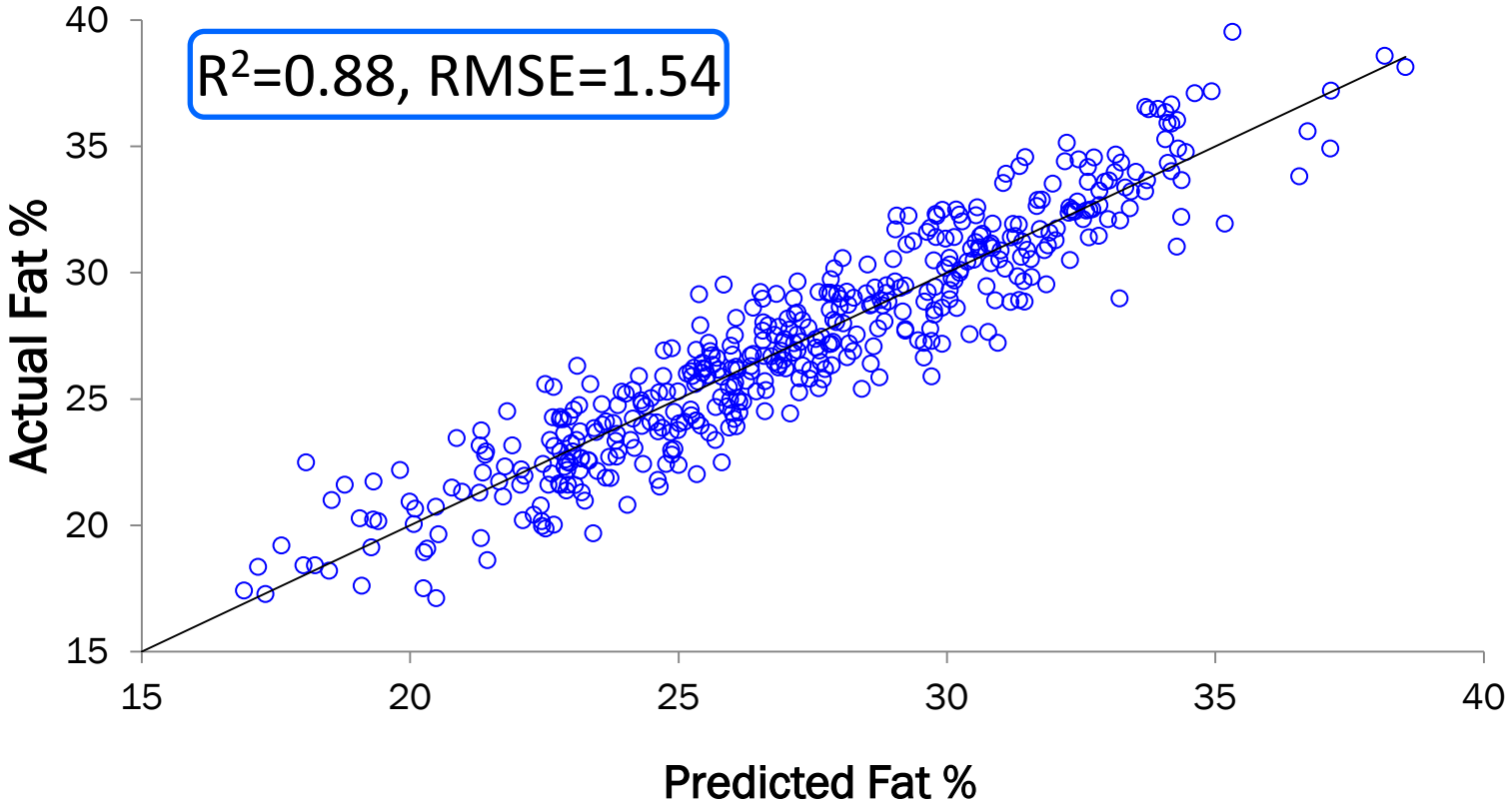
Nucleus Flock kill 2



Nucleus Flock kill 3

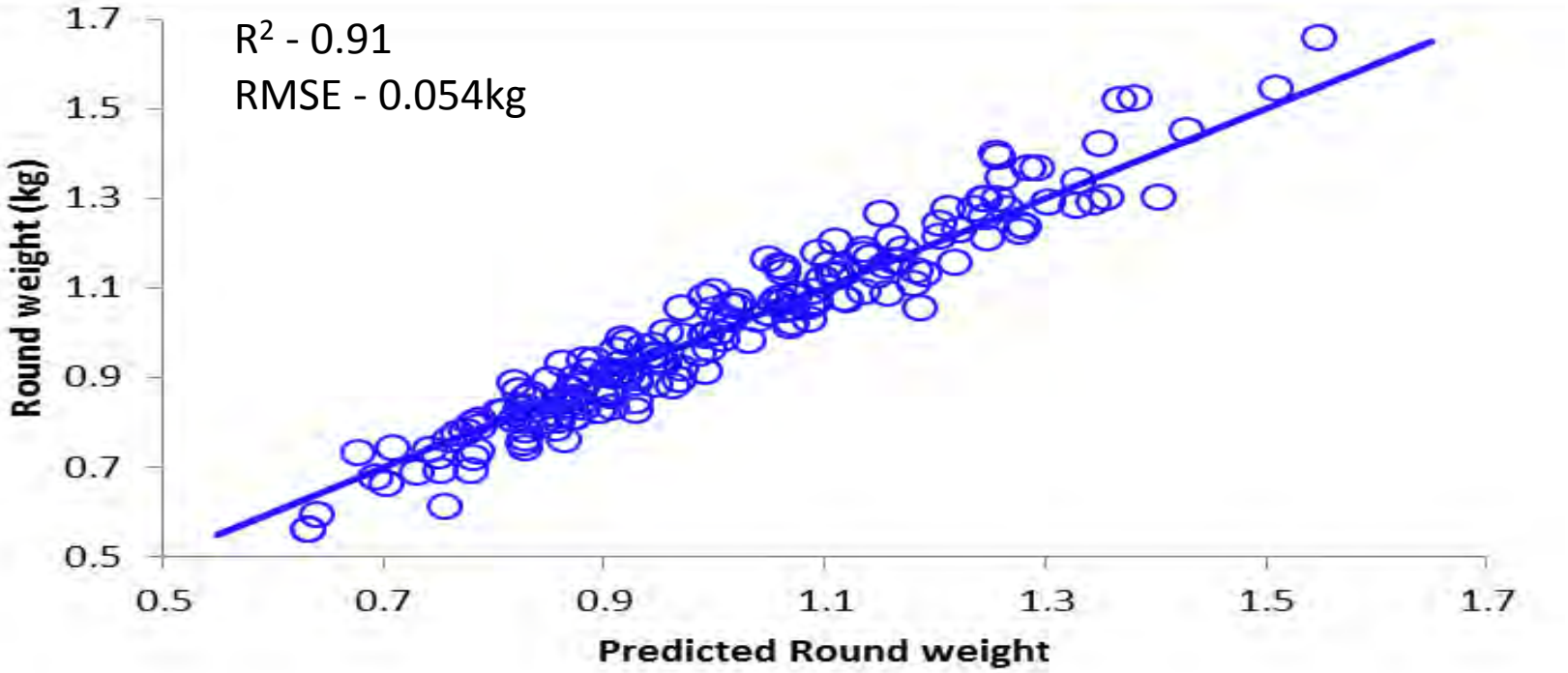


Predicting CT Fat%



Predicting round weight

using HCWT plus DEXAfat value



So where to next…?

- Predict cut weights
- Further hard-ware development
- Improved image analysis techniques
- Calibration systems
- Industry confidence

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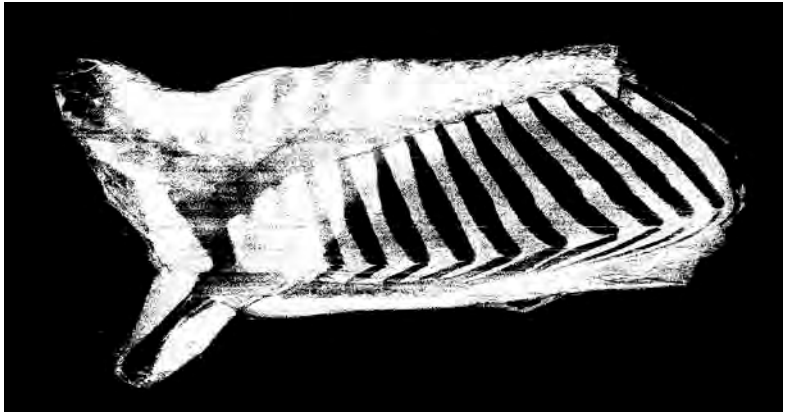
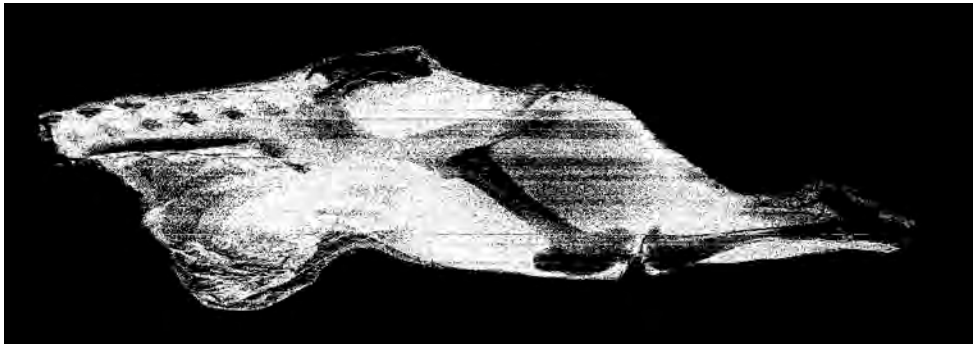
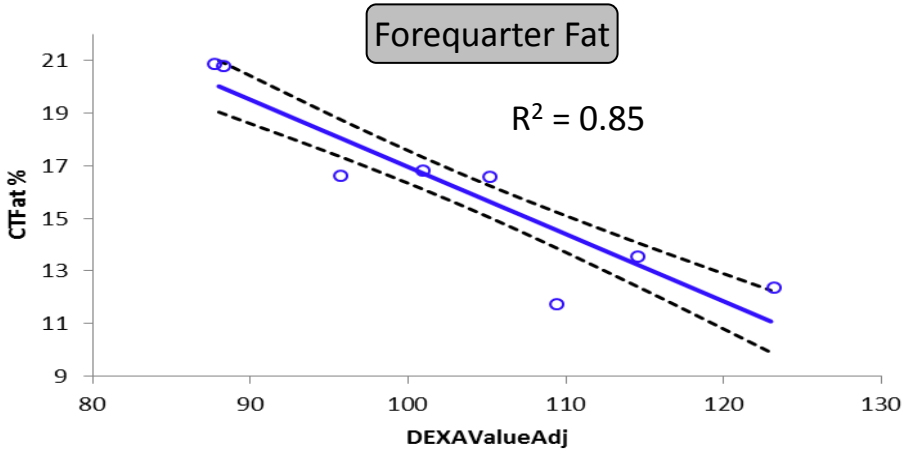
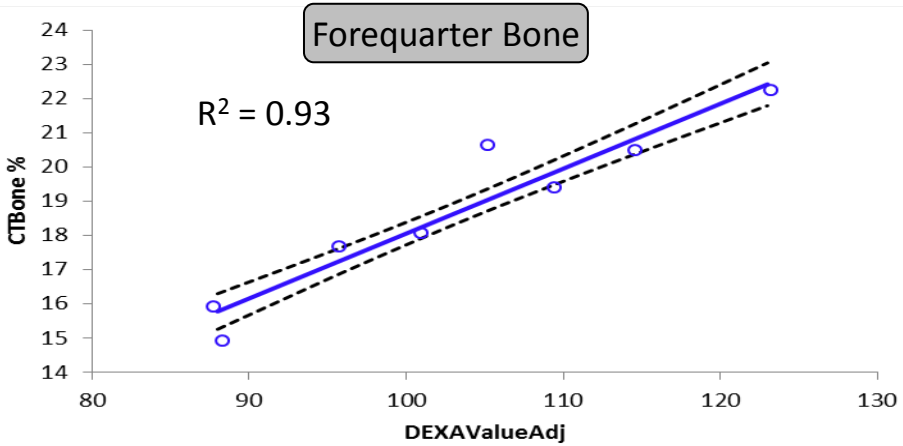
Beef DEXA

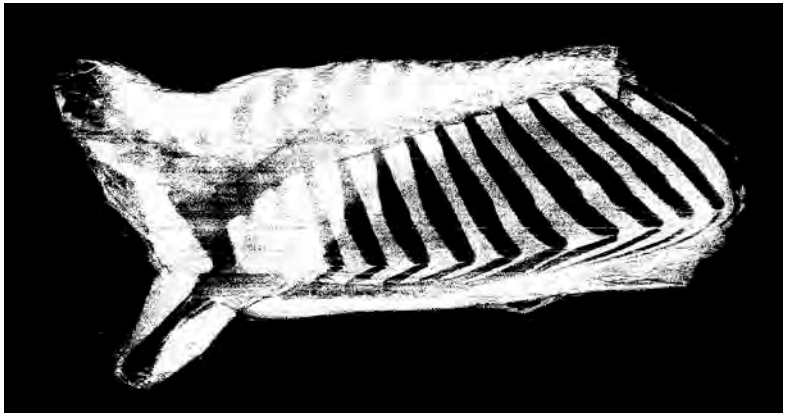


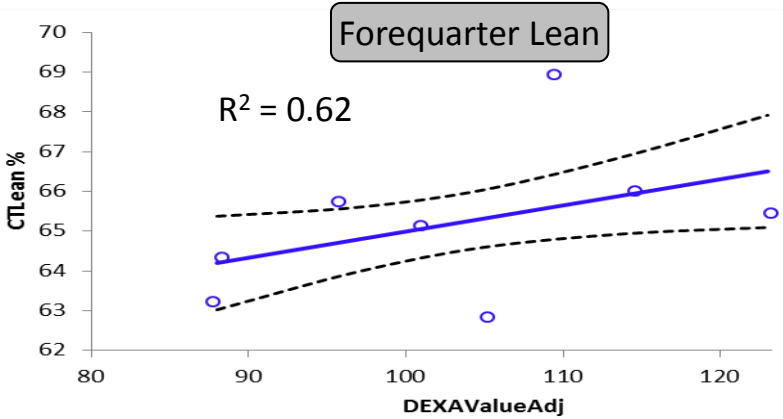


Beef DEXA Development





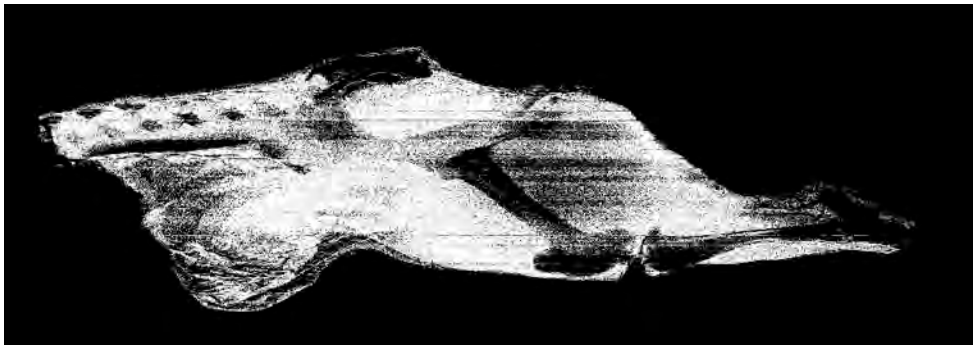




Beef DEXA Development

No association!

Weak association for hindquarter bone ($R^2 = 0.54$)



Eating Quality

“Let’s start with IMF”

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IMF Technologies

- Near infrared probe (hot carcase)
- Computed tomography (hot carcase)
- Electrical impedance probe (hot carcase)
- High resolution RGB camera (cold carcase)
- Hyperspectral camera (cold carcase)

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Hyperspectral Imaging

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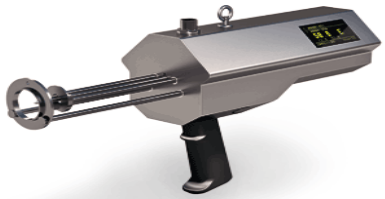
Carometec

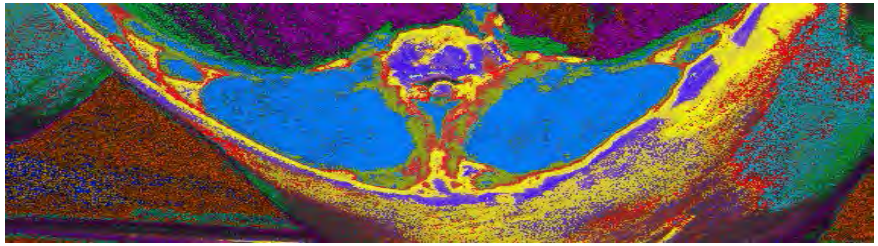


Fat-o-meter

Autofom

Ultrafom

Hyperspectral Camera



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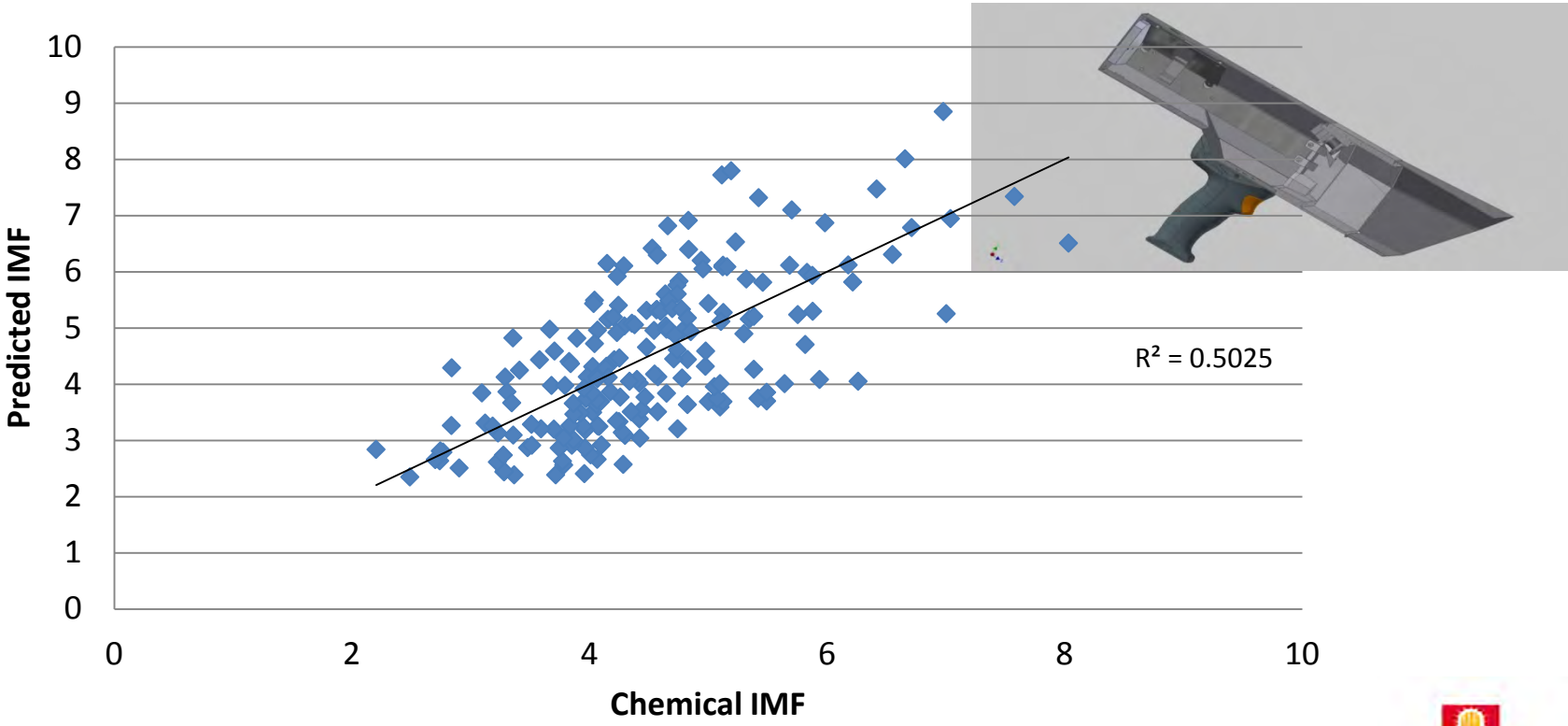
Hyperspectral IMF



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Hyperspectral Imaging

- For grading:
  - Eye muscle area
  - IMF (marbling scores)
  - Fat colour
  - Meat colour
  - Subcutaneous fat
  - Separate fat from bone and IMF from bonedust
  - Ossification

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A key component of MLA's R&D strategy

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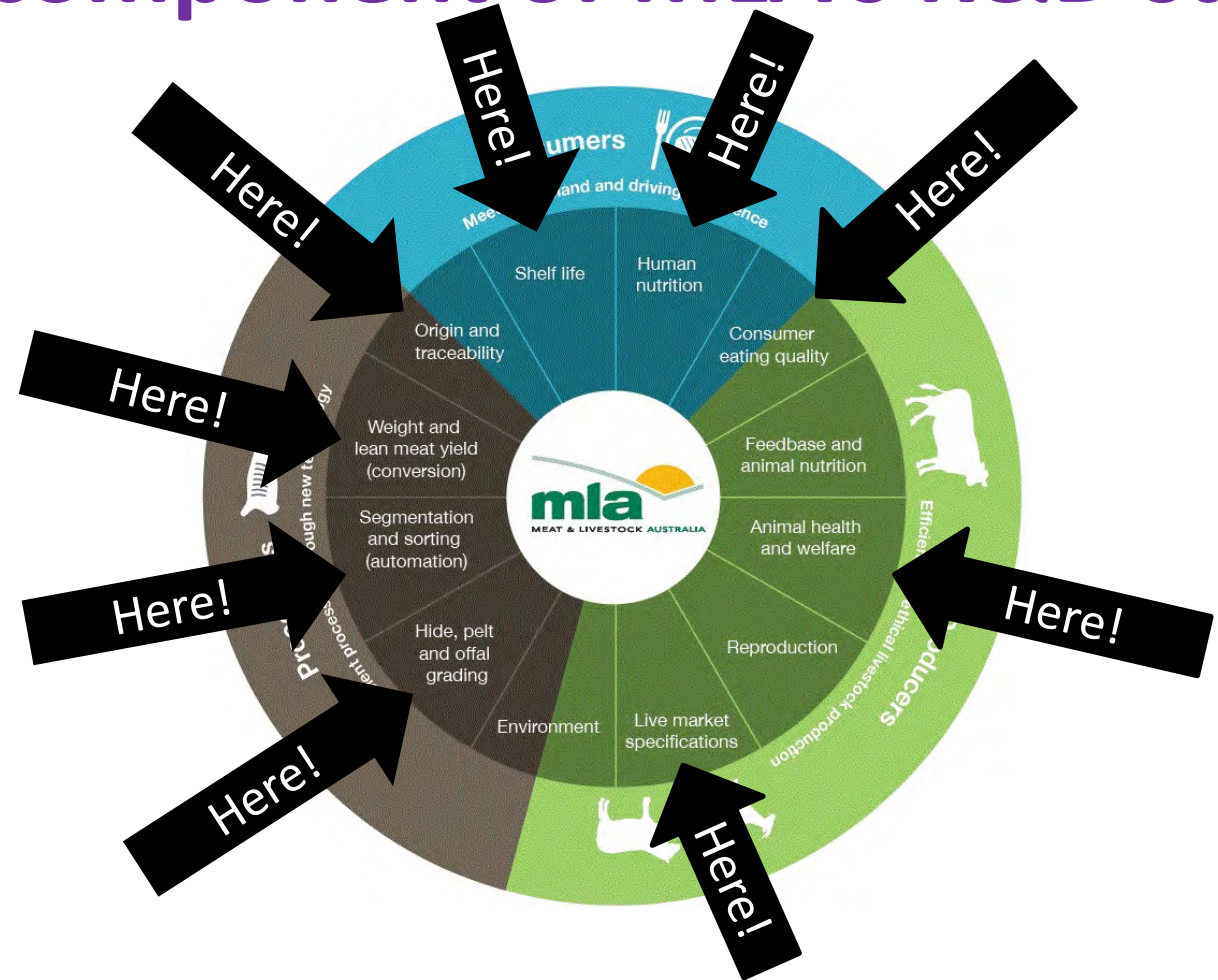
A key component of MLA's R&D strategy



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Summary

- Need carcase measurement:
  - transparency
  - LMY/Eating quality antagonism
- Advanced livestock measurement technologies
- Good progress in LMY measurement
  - DEXA one option
  - Still need cheap alternatives for small plants – GR, 3D
- IMF for eating quality promising
  - hyperspectral

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Summary

- Need carcase measurement:
  - Paid for what you produce!
- IMF for eating quality promising
  - hyperspectral

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Questions?

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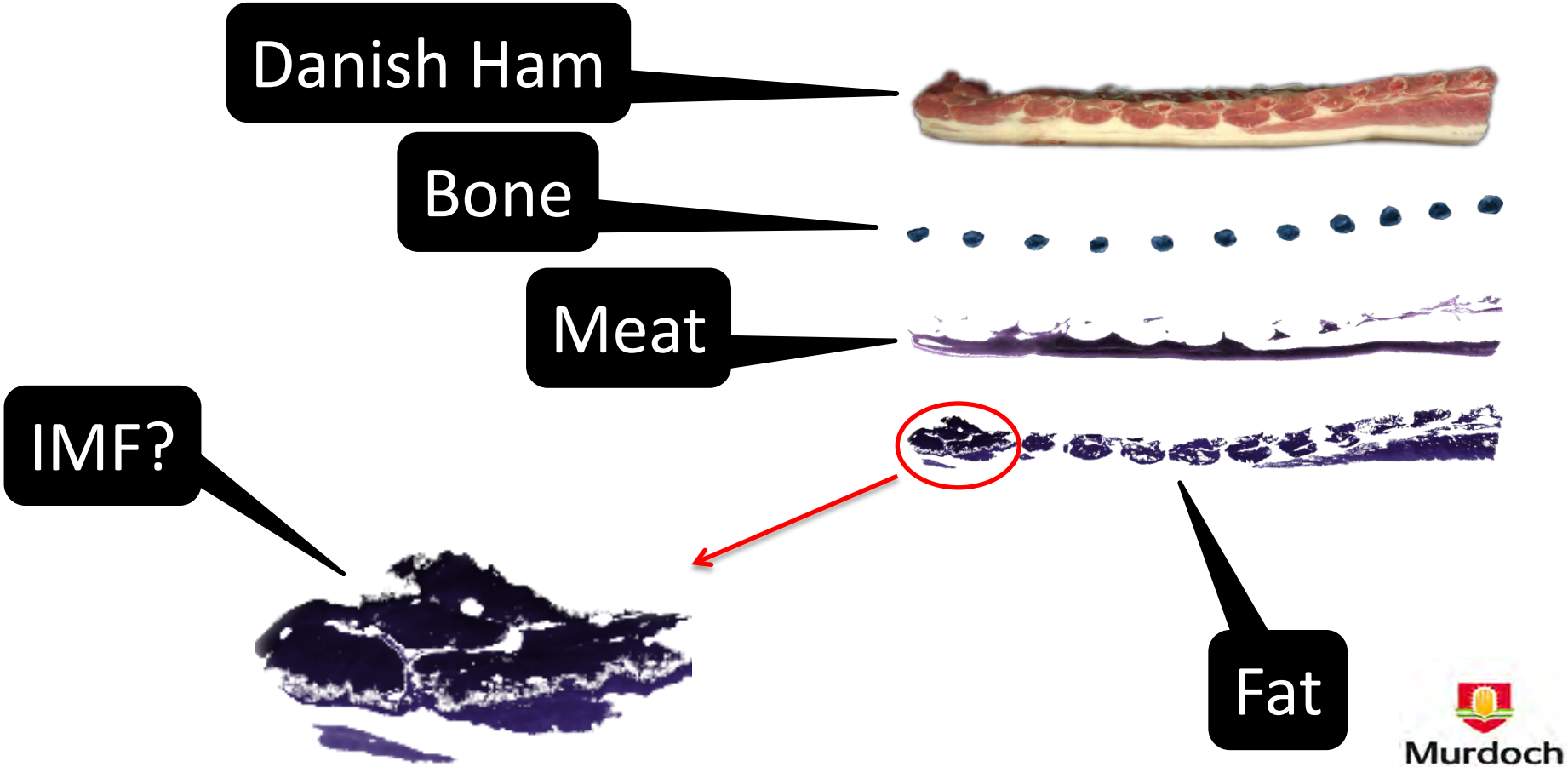
Hyperspectral Imaging



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Cheaper LMY alternatives

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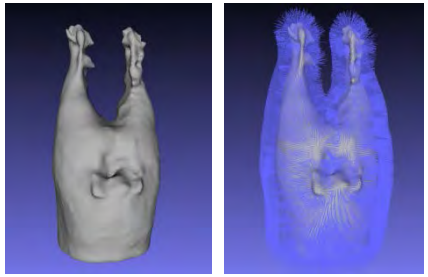
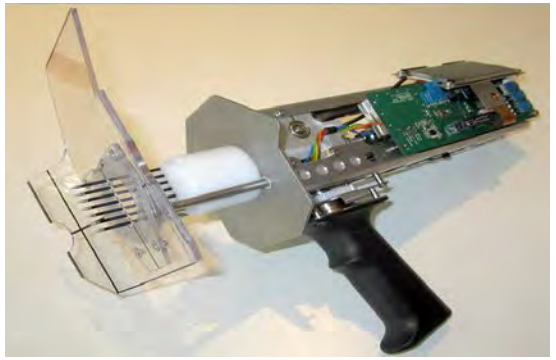


3D imaging



GR Probe

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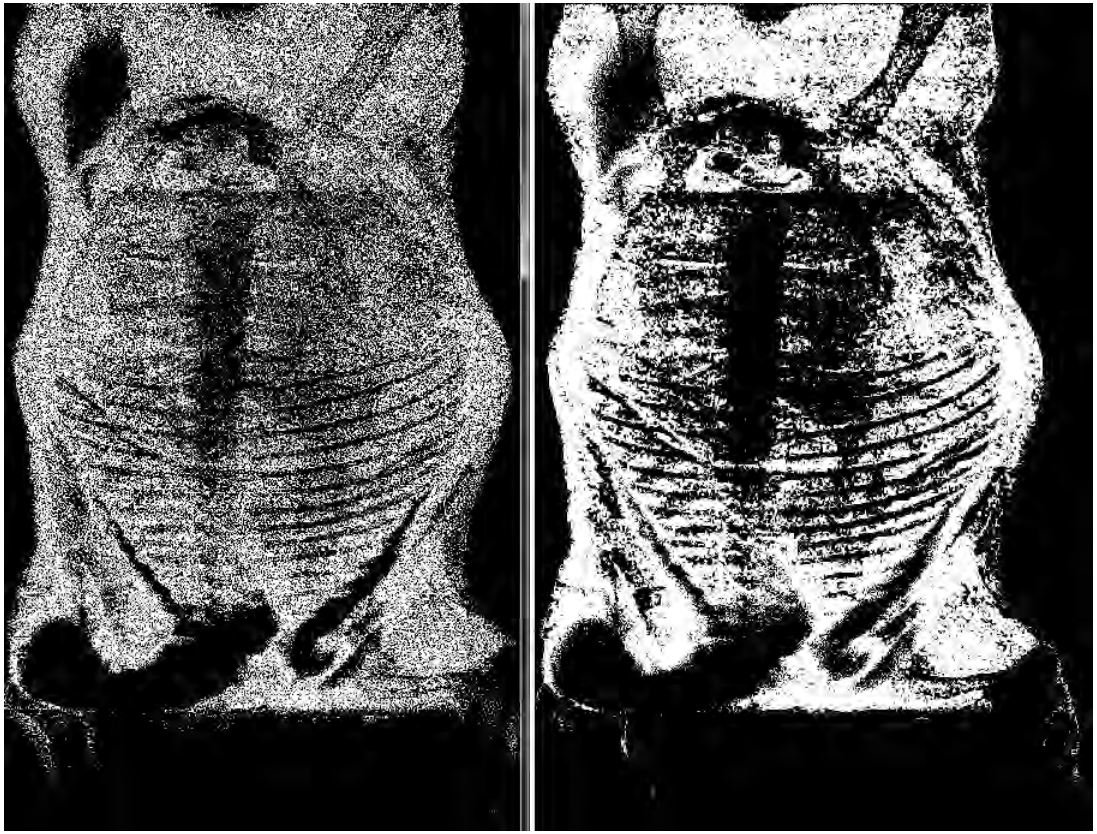
Improved image analysis



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Influence of abattoir factors?

- Spray chilling
- Carcase orientation (180 degree turn)
- Carcase temperature
- Time post mortem (but no loss in precision)

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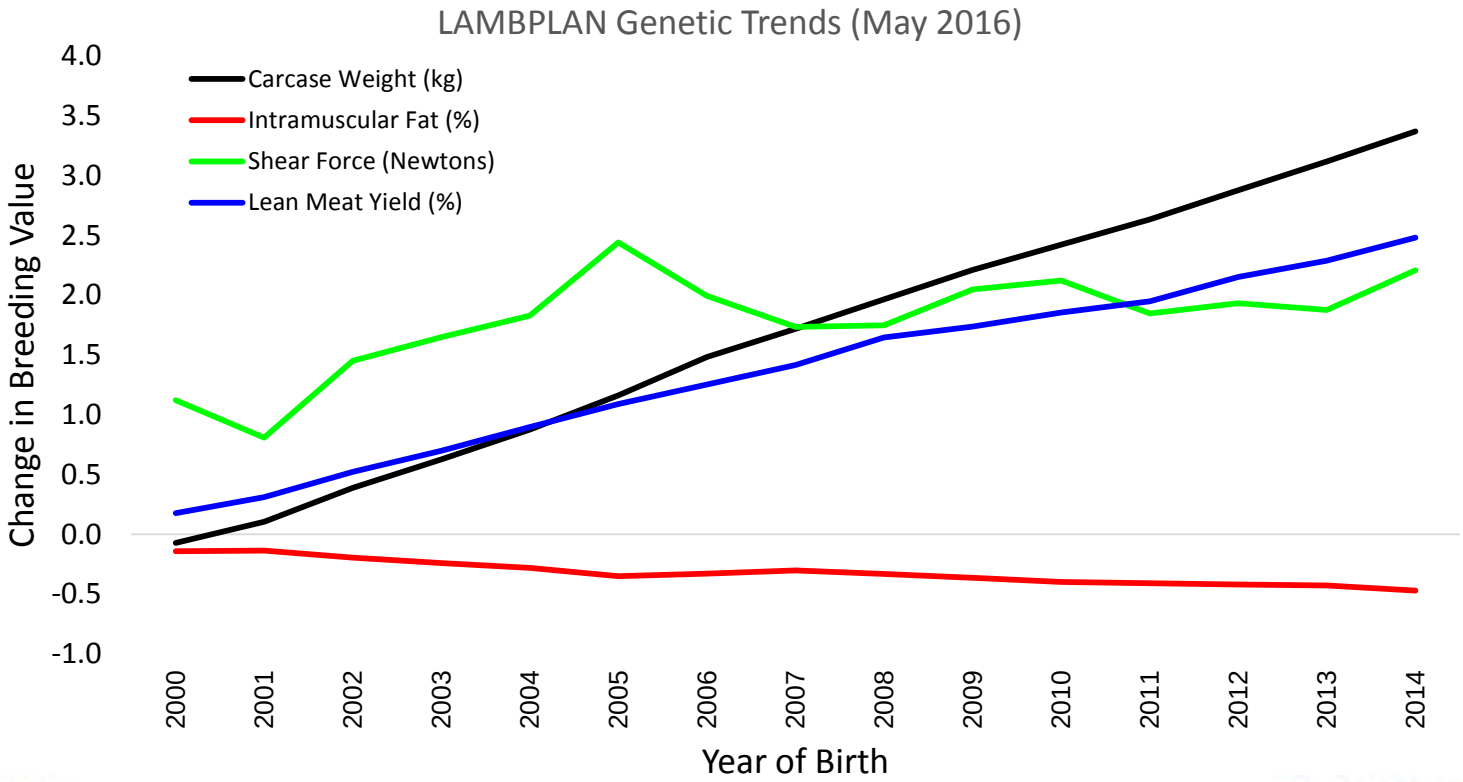
The genetic trend is worrying…



MERINOSELECT ASBV

LAMBPLAN ASBV

SHEEP GENETICS

mla

awi Australian Wool Innovation Limited

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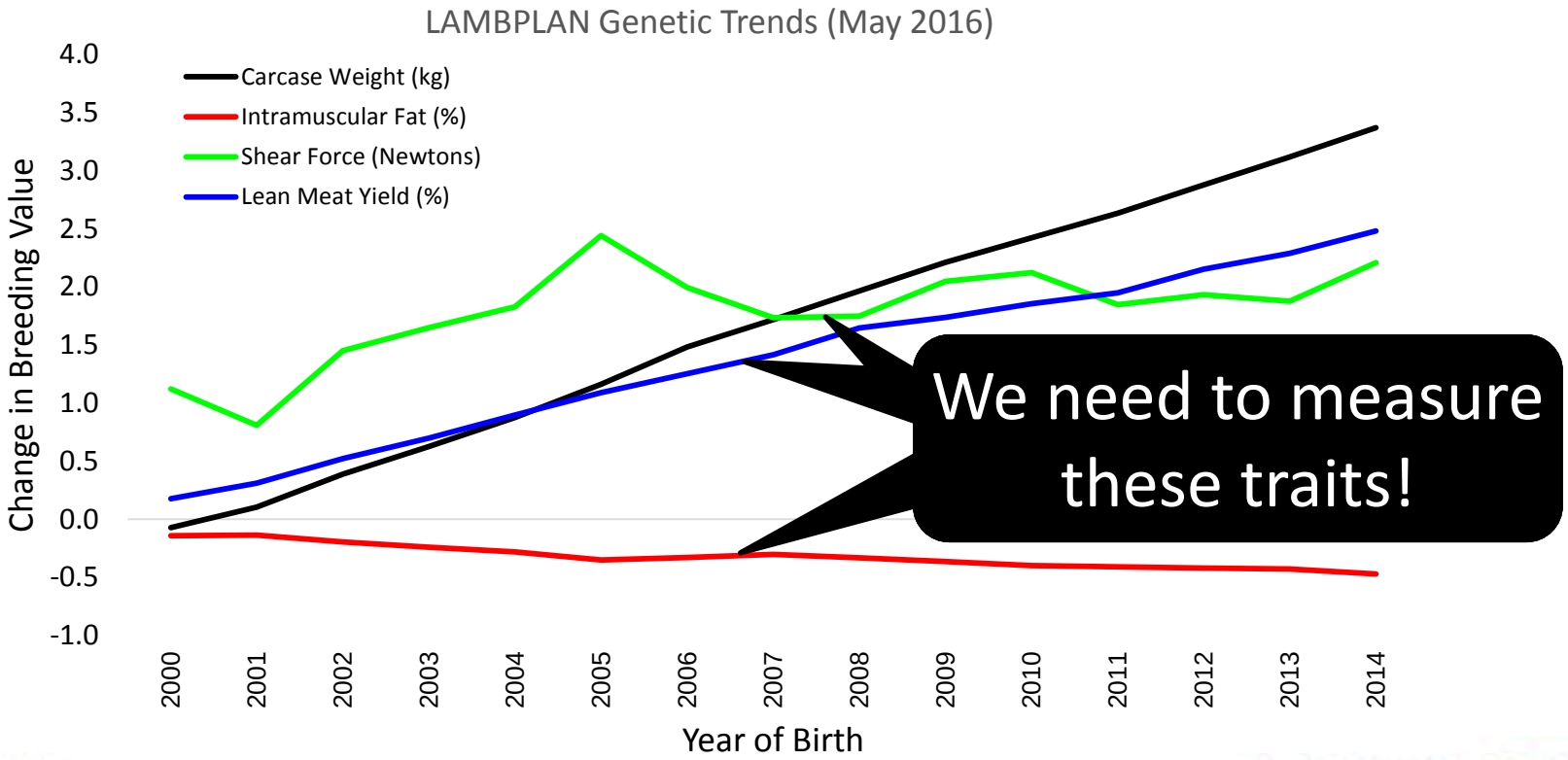

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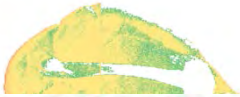
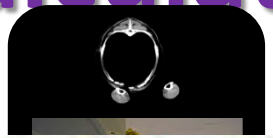
Carcase Calculator rework





Primal Weight Estimates

Trade: Over the Hooks. X-Breed Av. GR: 14.1mm Av. HCW: 23 kg Shrinkage: 2.5 %

Total Retail Valu $221.54

Carcase Gross Prof $35.55 16.0%

Back to Main Menu

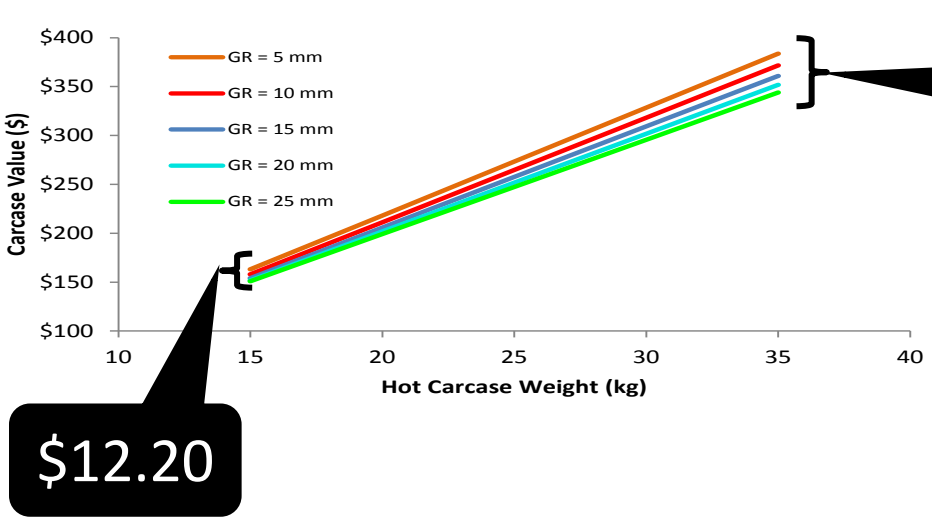
	Weight Kg		Weight Kg		Weight Kg		Weight Kg
Forequarter 4 Rib		Square Cut Shoulder Wholesale				Eye of Shoulder	0.349
						Boneless Shoulder	2.140
		Fore shank not tipped		Fore shank Tipped		Foreshank Trim	0.787
		Breast				Breast Trim	0.197
		Neck		Trimmed Neck		Neck Meat	0.325
Loin		Short Loin		Short Loin Trimmed		Short Loin No Tail		Eye of Shortloin	0.726
								Tenderloin Butt	0.165
		Rack (8 Rib) 75 mm tail				USA Rack Cap Off (8 Rib) Frenched 50mm		Eye of Rack	0.625
		Flap		Boneless Flap (untrimmed)				Trimmed Boneless Flap 5cl	1.461
Leg		Leg Chump On Tipped (6mm		Leg Aitch Bone		Boneless Leg Chump on Shank Off		Topside	1.254
								Round	0.515
								Silverside	0.397
								Rump	0.524
								Butt Tenderloin	0.119
		Total Lean	0.979			Hind Shank B/I		Hind Shank B/O	0.647

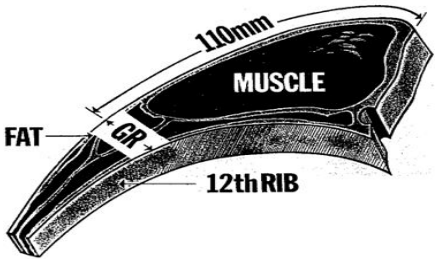
DEXA Lean Value = 52

DEXA Lean Value = 48

DEXA Lean Value = 59

What does extra precision mean for the carcase calculator?





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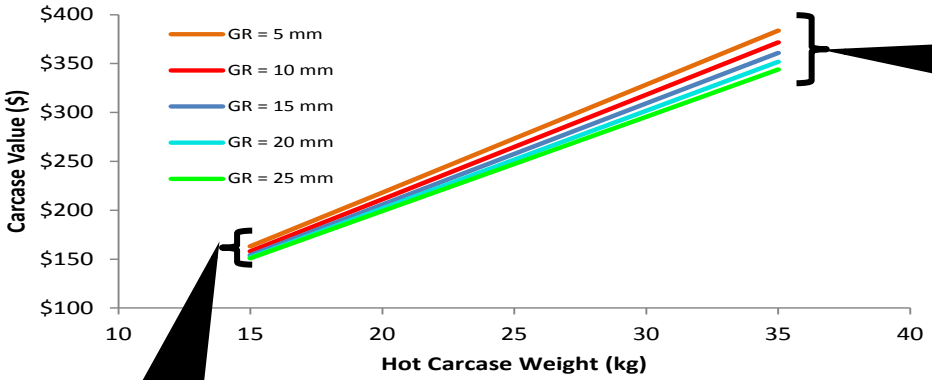
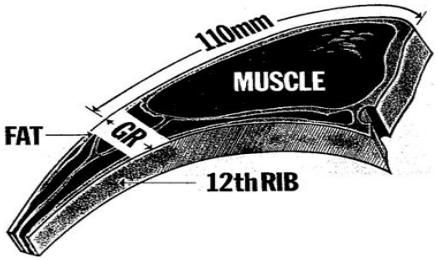
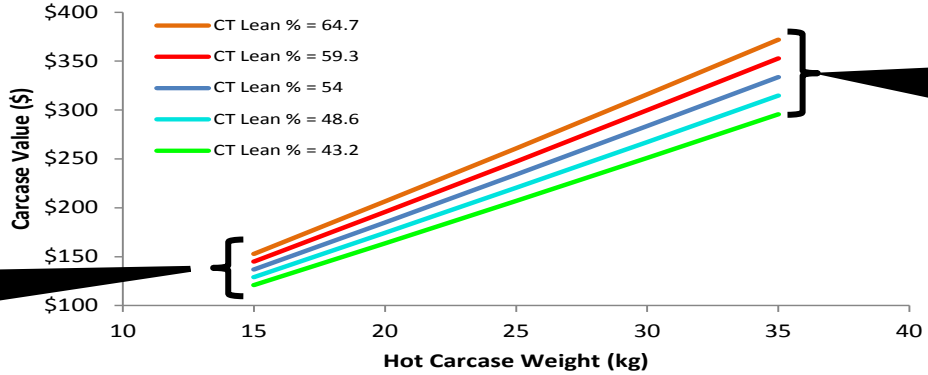


$39.70

$12.20





$31.91

$76.15

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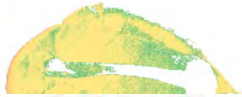
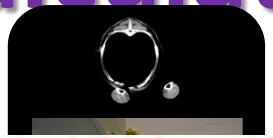
Carcase Calculator rework





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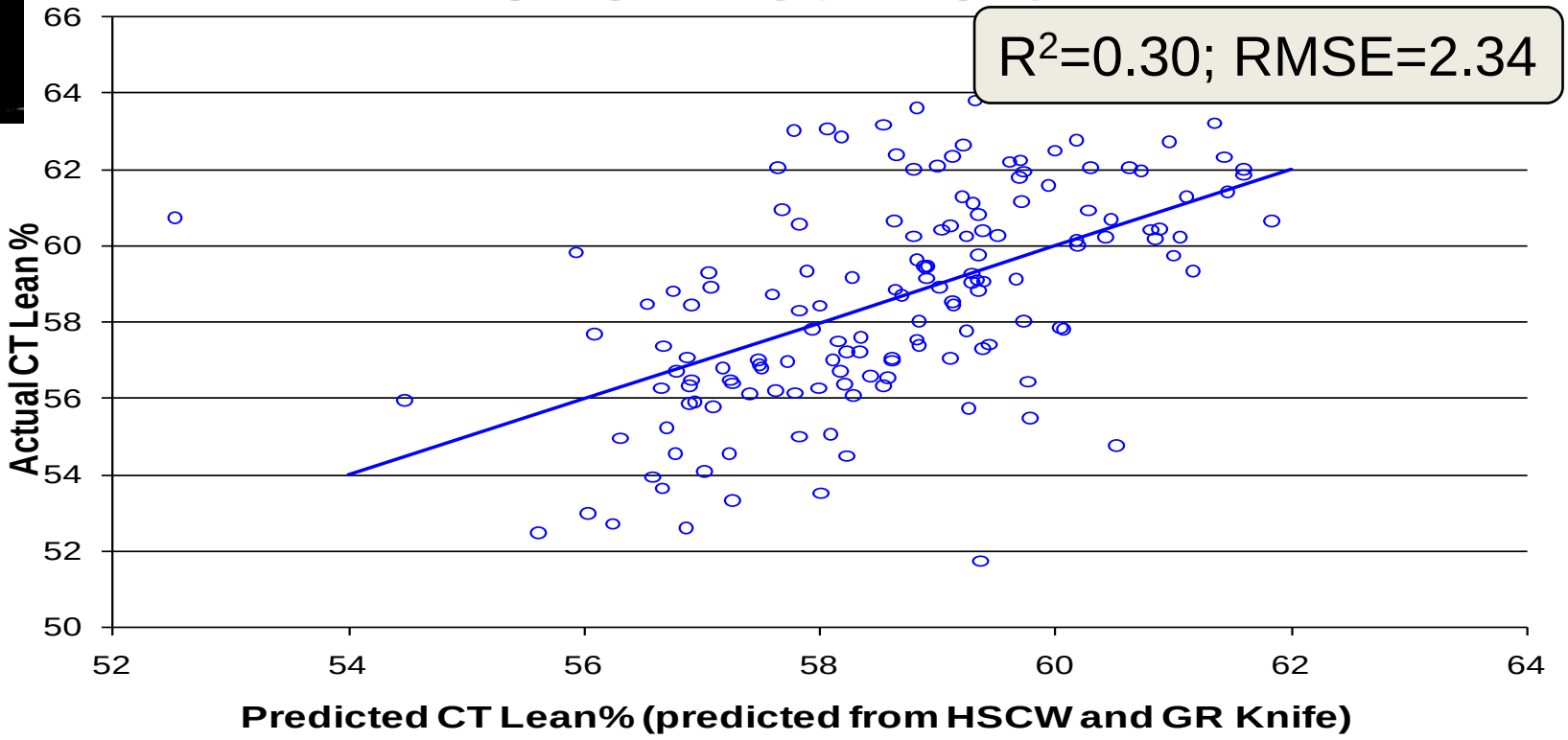
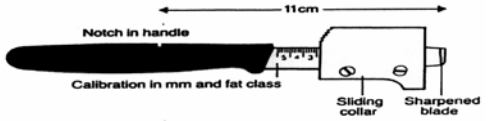
Knife GR & HSCW

R^2=0.30; RMSE=2.34





Capturing the value of LMY%

Grid Ref - Week: 7 — Valid For Kills: 24/2/14-28/2/14

XB La		Grade Price / HSCW Range							
Grade	Fat	20.1-22.0	22.1-24.0	24.1-26.0	26.1-28.0	28.1-30.0	30.1-32.0	32+
S1	0	$4.70	$4.70	$4.70	$4.70	$4.70	$4.70	$4.20
S2	6	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$4.50
S3	11	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	$4.50
S4	15	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	
S5	20	$5.00	$5.00	$5.00	$5.00	$5.00	$5.00	

Price Grid

Immediate supply response
a) Supply may increase (if bonus system)

Long Term Population Response to Selection
Estimate yield gain/yr in response to price signal

Immediate quality response
Producers with good muscling genetics will target grid

Carcase Sorting
Optimise allocation of carcases to different fabrication end-points

Boning Room:
Less Fat Trim/Labour

Retail: Cut Consistency

Yield Measurement

Boning Room: Benchmark Efficiency
Boning error = difference between expected versus actual saleable meat

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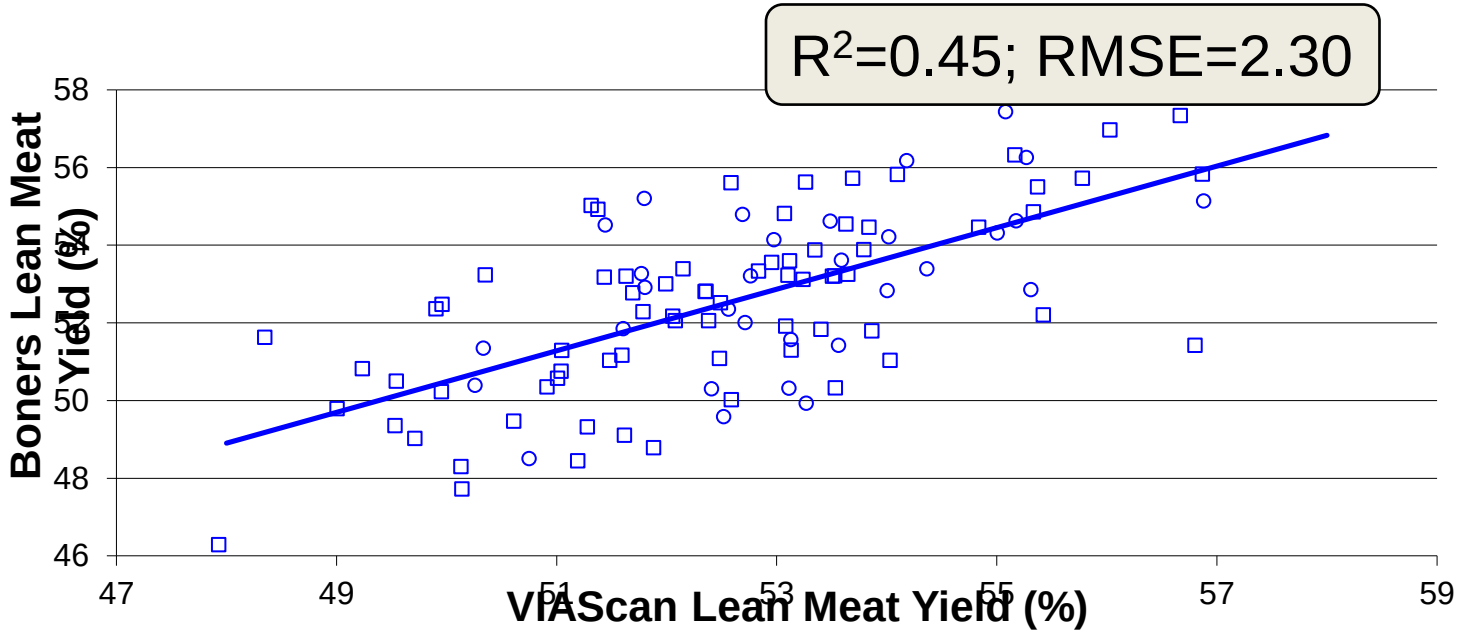
VIAscan predicts lean meat yield



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Cut weights and tissue depths

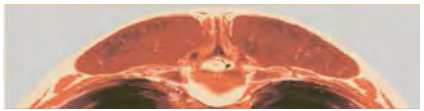
R^2=0.66; RMSE=1.63

Actual CT Lean %

66
64
62
60
58
56
54
52
50

52 54 56 58 60 62 64 66

Predicted CT Lean% (predicted from Cut Weights)



Precision measurement
from paddock/pen to plate

- Predict quality and amount of final product

Forecast carcase fat, muscle & bone from live animal

Producer Feedback

Predict cut wt

Conception | Live Animal | Carcase | Retail Cuts | Cooked Product

Value | Value | Value | Value

Optimal use of carcases

LMY

Data to genetic databases

3D Imaging

DEXA

GR Probe

Predict eating quality

Eating Quality:

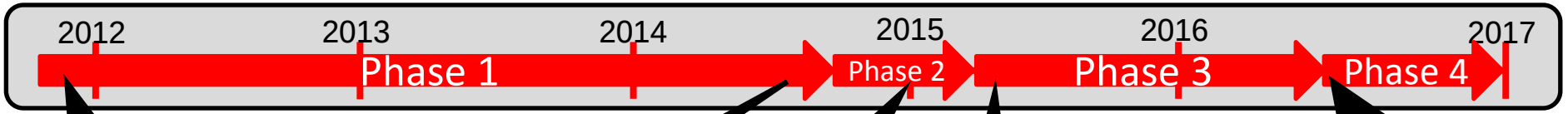
Hyperspectral

NitFom

Synergy with Automation

Lamb DEXA Development

- Sooner the better!

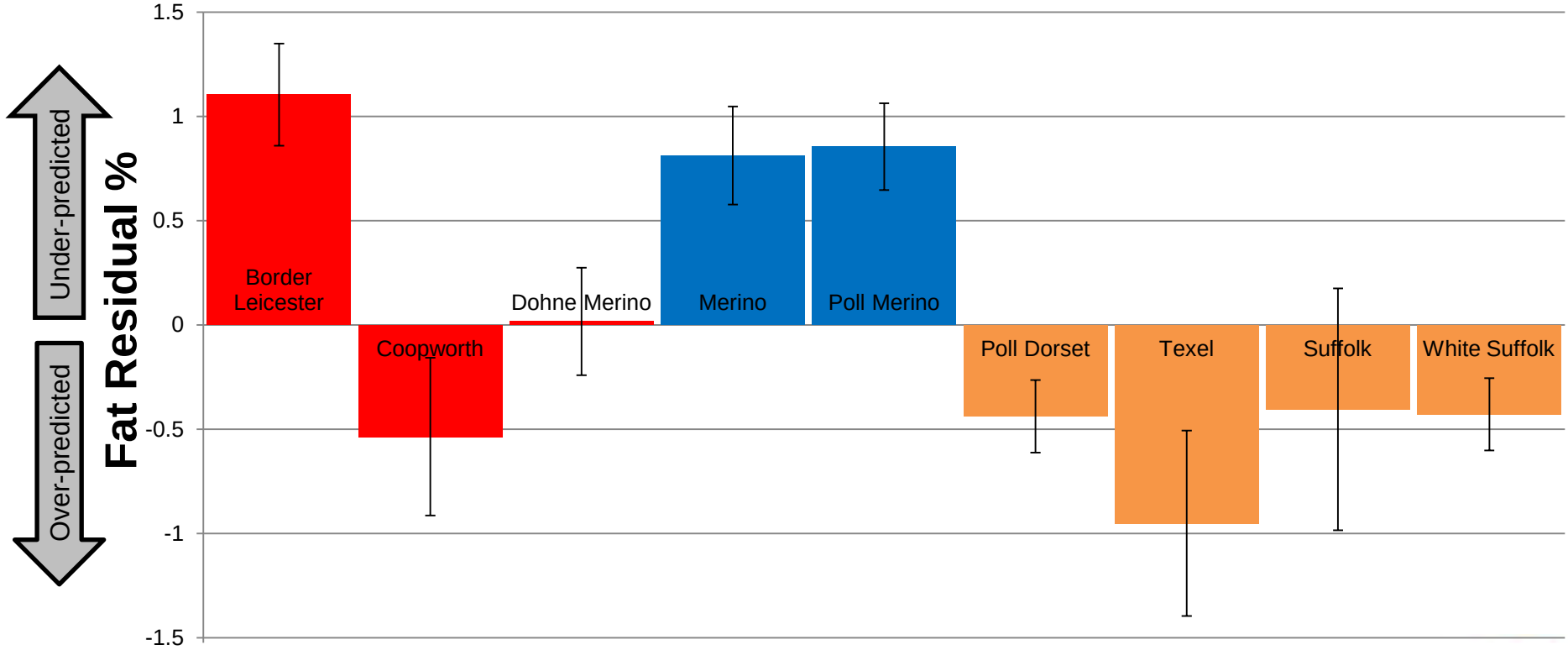


1st Prototype test

Expt prototype ready

Test processing factors

Collect calibration data using com. prototype

Com. prototype ready! Support adoption

Residual effects of sire breed