

Technologies to predict eating quality in Australian beef carcasses

Liselotte Pannier

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Australian Government
Department of Agriculture

Outline

- Value based marketing
- Trading on eating quality – MSA marbling a key trait
- Beef grading technologies being investigated
- Industry linkage and decision making = crucial for commercialisation by industry!

Value based marketing



Carcass value
(\$)

=



Quantity
saleable
meat (kg)

X



Quality of the
meat (\$/kg)

Value based marketing



Carcass value
(\$)

CARCASS YIELD



Quantity
saleable
meat (kg)

EATING QUALITY



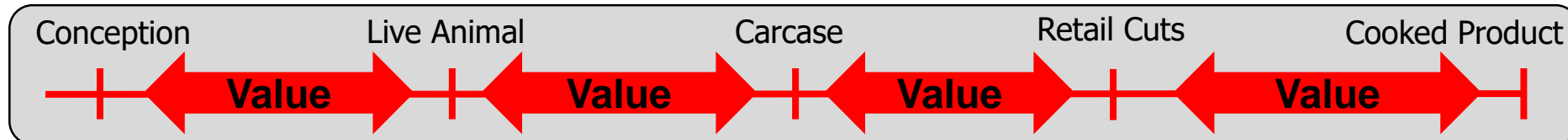
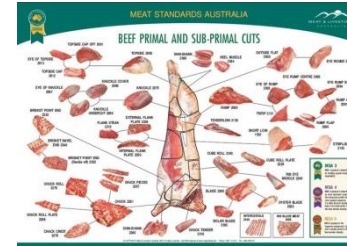
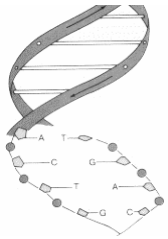
Quality of the
meat (\$/kg)

=

X

Precision measurement from paddock/pen to plate

- Predict quality and amount of final product



Trading on Eating Quality

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	
more Growth Promotent	Y or ? / N	HGP	n	
MilkFedVesler	Y/N	MFV	n	
SaleYard	Y/N	SIYrd	n	
Rinse/Flush	Y/N	RnFI	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	
Ultimate pH	Metered pH	UpH	5.5	
Loin Temp at Grade	Metered Temp C	Uttmp	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			
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	blade	BLD096	53	57	58	59	59	
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	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	
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	intercostal	INT037			57			



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	brisket	BRI057			41	49	64	
	shin	FQshin					57	
	shin	HQshin					60	
	intercostal	INT037			57			



Animal and Carcass
Fixed and covariate
inputs

Trading on Eating Quality

at Standards Australia eating quality model



Carcase Wt

Format	Name	Input	?	Aged
EPBI	EPBI	0		
Sex	Sex	F		
HGP	HGP	n		
MAI	MAI	n		
SIYrd	SIYrd	n		
AnFI	AnFI	n		
HCW	HCW	350		
Hang	Hang	at		
Hump	Hump	63		
uoss	uoss	290		
umf	umf	30		
Rib	Rib			
UH	UH			
Ump	Ump			



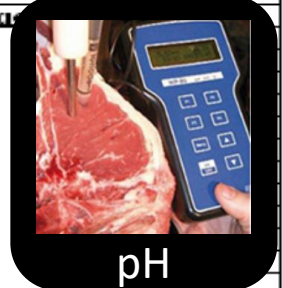
Ossification



IMF



Rib Fat Depth



pH



Hump Height

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shin	FQshin					57	
shin	HQshin					60	
intercostal	INT037			57			

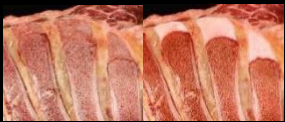


Trading on Eating Quality

Meat Standards Australia eating quality model



Carcase Wt



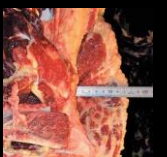
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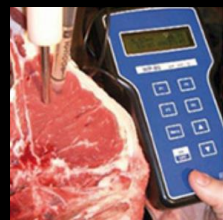
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Rib Fat Depth



Hump Height



pH

Format	Name	Input	?	Aged	cut	muscle	GRL	RST	SFR	TSL	SCT	CRN
EPBI	EPBI	0			spinalis	SPN081	79	69	79	75		
Sex	Sex	F			tenderloin	TDR034	82		76			
HGP	HGP	n			tenderloin	TDR062	78	77	80	74		
SIYrd	SIYrd	n			tenderloin	TDR063	73					
cube roll	CUB045				cube roll	CUB045	62	62	62	64		
striploin	STA045				striploin	STA045	55	56	58	58		
striploin	STP045				striploin	STP045	53	54	57	57		
ogster blade	OYS036				ogster blade	OYS036	67	64	69	72		
blade	BLD095				blade	BLD095			43			
blade	BLD096				blade	BLD096	53	57	58			
chucktender	CTR085				chucktender	CTR085		49	51			
rump	RMP131				rump	RMP131	51	59				
rump	RMP231				rump	RMP231	54	62				
rump	RMP005				rump	RMP005	59					
rump	RMP032				rump	RMP032			64			
rump	RMP087				rump	RMP087		52	57	55		
knuckle	KNU066				knuckle	KNU066	46	59	54	58		
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knuckle	KNU100				knuckle	KNU100			60	62		
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eye round	EYE075				eye round	EYE075	40	44	42	45		
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intercostal	INT037				intercostal	INT037			57			

Model outputs Eating quality prediction for each cut x cook option



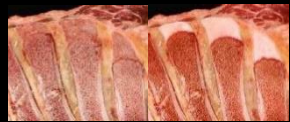
Trading on Eating Quality

Meat Standards Australia eating quality model



Carcase Wt

Format	Name	Input	?	Aged
EPBI	EPBI	0		
Sex	Sex	F		
HGP	HGP	n		
SIYrd	SIYrd	n		
KnFI	KnFI	n		
HSW	HSW	350		
Hang	Hang	at		
Hump	Hump	63		
uoss	uoss	290		
umf	umf	30		
UH	UH			
Ump	Ump			



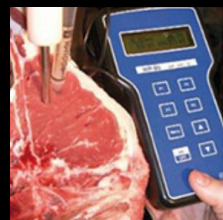
Ossification



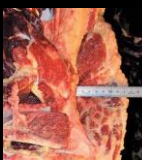
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Rib Fat Depth



pH



Hump Height

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FIT FOR PURPOSE PRODUCT

Trading on Eating Quality

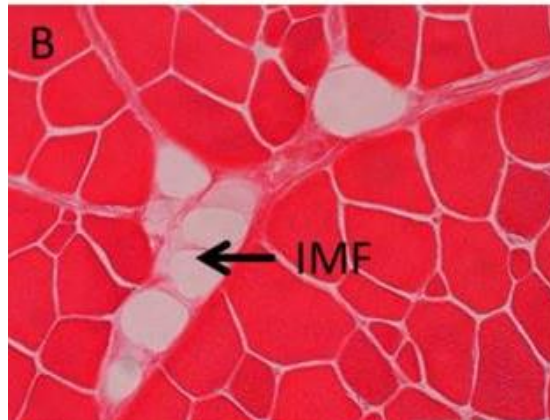
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IMF

**INTRAMUSCULAR
FAT%**



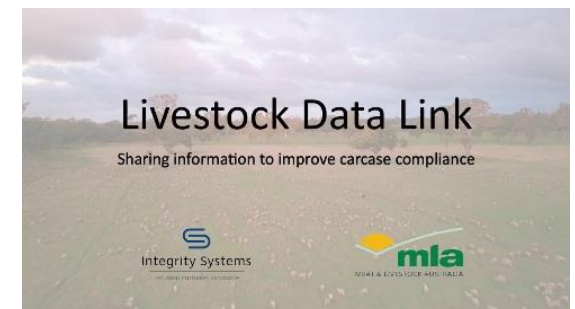
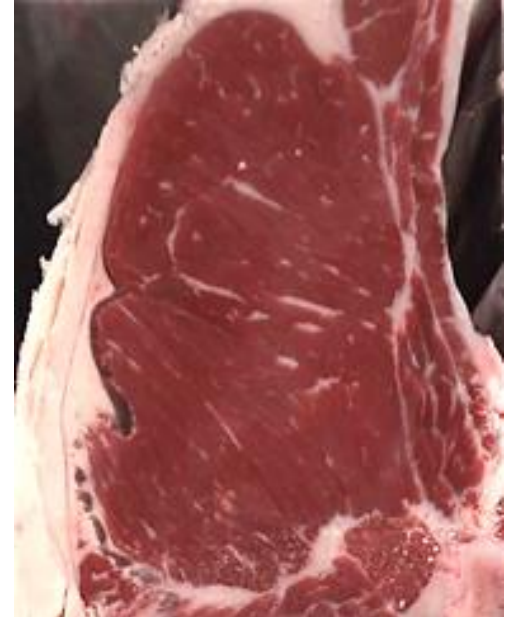
← IMF

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			63	56	61	67	72	
			56	57	58	62	69	
					60	64	75	
					52	56		
					58		58	
					67	59	64	
					61	58	60	
					48			
					44	58	60	38
					41	49	64	
							57	
							60	
					57			



Why is IMF% important?

- Positive effect on beef palatability
- Tenderness, flavour, juiciness
- Describes about 15% of variation in consumer EQ scores in beef
- Its what the consumer eats
- One of the few on-farm decision points to improve eating quality
 - Young beef (<24 months old) British/Euro breed type production system
- Accurate + precise feedback is crucial



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Trading on Eating Quality

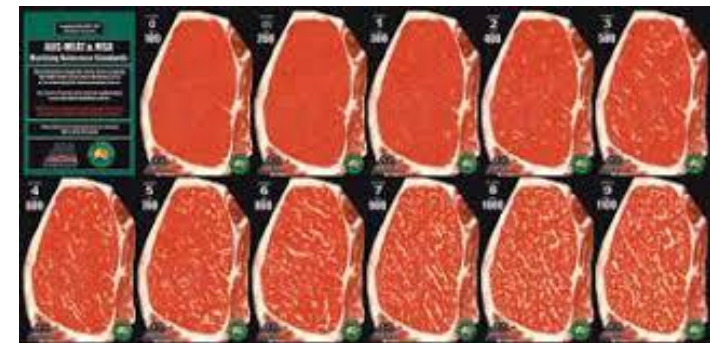
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Increasing number relates to amount and distribution

Visual Marbling

- Visual representation of intramuscular fat (IMF%) at the grading surface (loin eye)
- Language of the Meat Standards Australia (MSA) grading system
- Subjective assessment of quantity and distribution of IMF%



Visual marbling

M



Human estimated scores = error?



Visual marbling

M

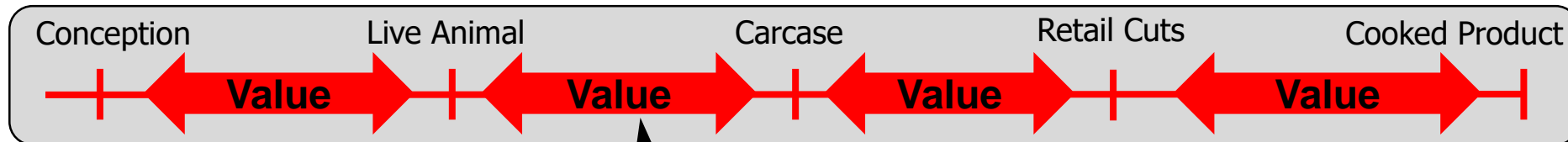
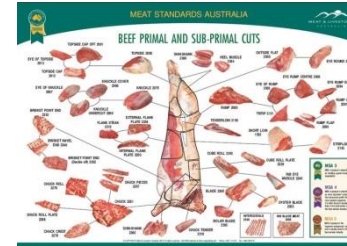
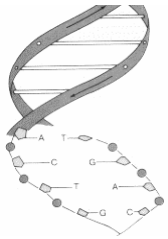


EATING QUALITY



Precision measurement from paddock/pen to plate

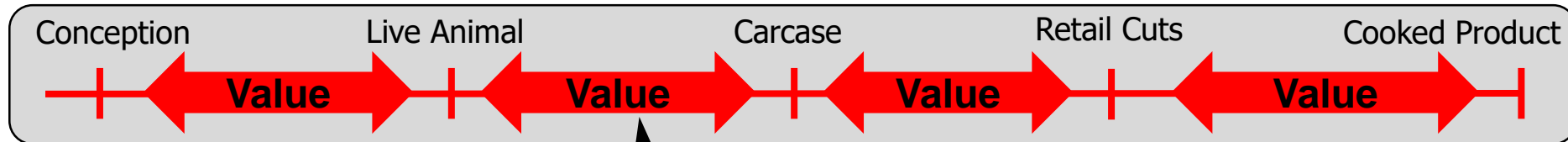
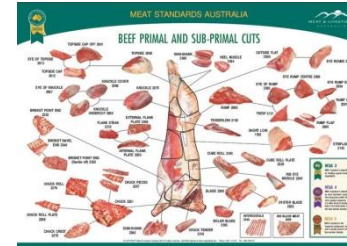
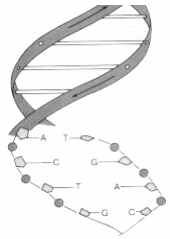
- Predict quality and amount of final product



Trading lacks
transparency?

Precision measurement from paddock/pen to plate

- Predict quality and amount of final product



Senate inquiry

Trading lacks
transparency?

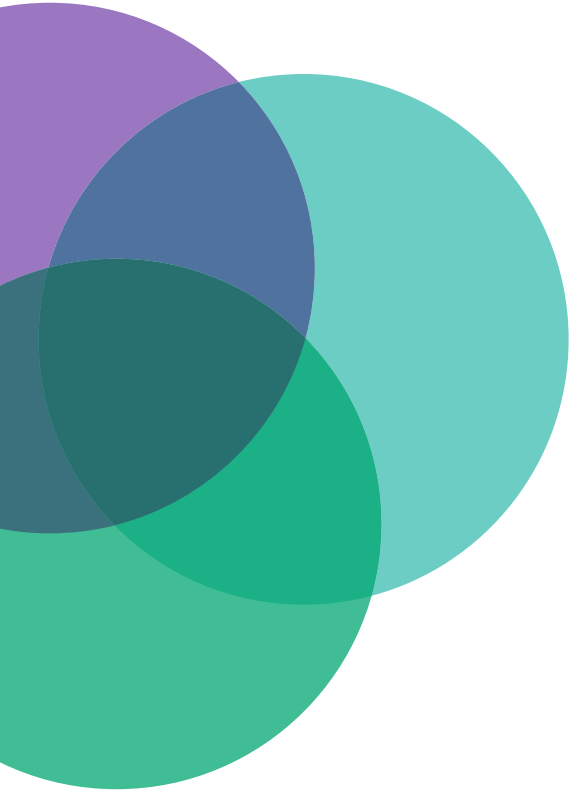
= political impetus
for change!



Australian Government
**Department of Agriculture
and Water Resources**



Advanced Livestock Measurement Technologies

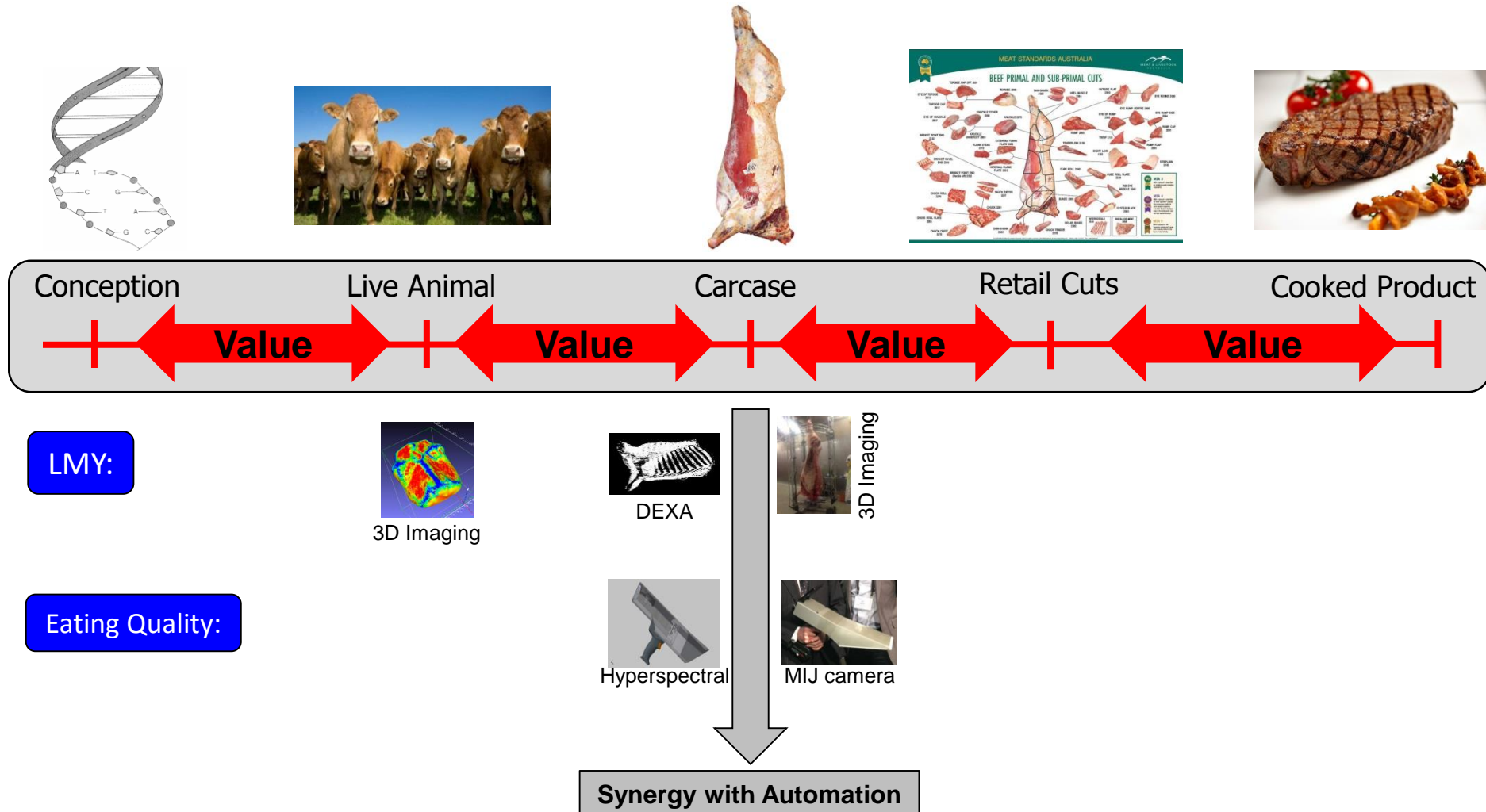


This project is supported by funding from the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit programme in partnership with Research & Development Corporations, commercial companies, state departments and universities



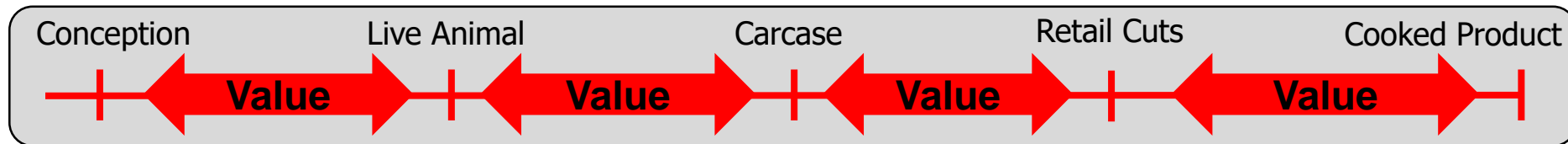
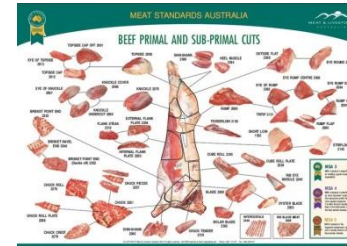
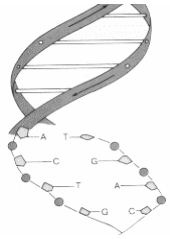
Precision measurement from paddock/pen to plate

- Predict quality and amount of final product



Precision measurement from paddock/pen to plate

- Predict quality and amount of final product



New Breeding Values

Systems to improve compliance

Enhanced Beef MSA

Benchmarking systems

Cut wt prediction systems

Enhanced Producer Feedback

Cuts-based Lamb MSA

Profit functions to optimise carcass use

Deliverables - Eating Quality Objective

The development of TWO measurement systems
for Eating Quality by July 2020



Trading on Eating Quality

Meat Standards Australia eating quality model

Description	Format	Name	Input	?	Aged	cut	muscle	GRL	RST	SFR	TSL	SCT	CRN
Estimated % Bos Indicus	% or X if doubt	EPBI	0			spinalis	SPN081	79	69	79	75		
Animal Sex Type	M/F	Sex	F			tenderloin	TDR034	82		76			
more Growth Promotent	Y or ? / N	HGP	n			tenderloin	TDR062	78	77	80	74		
MilkFed/Vesler	Y/N	MFV	n			tenderloin	TDR063	73					
SaleYard	Y/N	SIYrd	n			cube roll	CUB045	62	62	62	64		
						striploin	STA045	55	56	58	58		
Rinse/Flush	Y/N	RnFI	n			striploin	STP045	53	54	57	57		
Hot Std Carcase Weight	Weight in Kg	HSCW	350			ogster blade	OYS036	67	64	69	72		
HangMethod	T/TS/TL/TX/XT	Hang	at			blade	BLD095			43			
						blade	BLD096	53	57	58	59	59	
Hump Height	mm	Hump	63			chucktender	CTR085		49	51	53	59	
Ossification USDA	USDA measure	uoss	290			rump	RMP131	51	59	56	62	54	
Marbling USDA	USDA measure	umb	300			rump	RMP231	54	62	61	60		
	mm	RbFt	10			rump	RMP005	59		67	67		
	Metered pH	UpH	5.5			rump	RMP032			64	68		
	Metered Temp C	Uttmp	9			rump	RMP087		52	57	55	56	
	Days Aged	Age	5			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	OUT095		49	49	50	50	52



IMF and Marbling = the obvious place to start



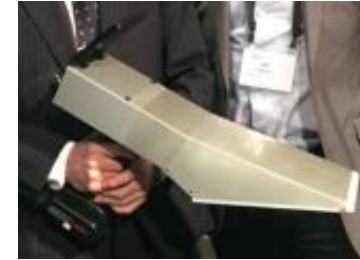
Multiple devices being tested!



E+V



Hyperspectral
(Frontmatec)



MIJ



MEQ Probe



Visual
grading



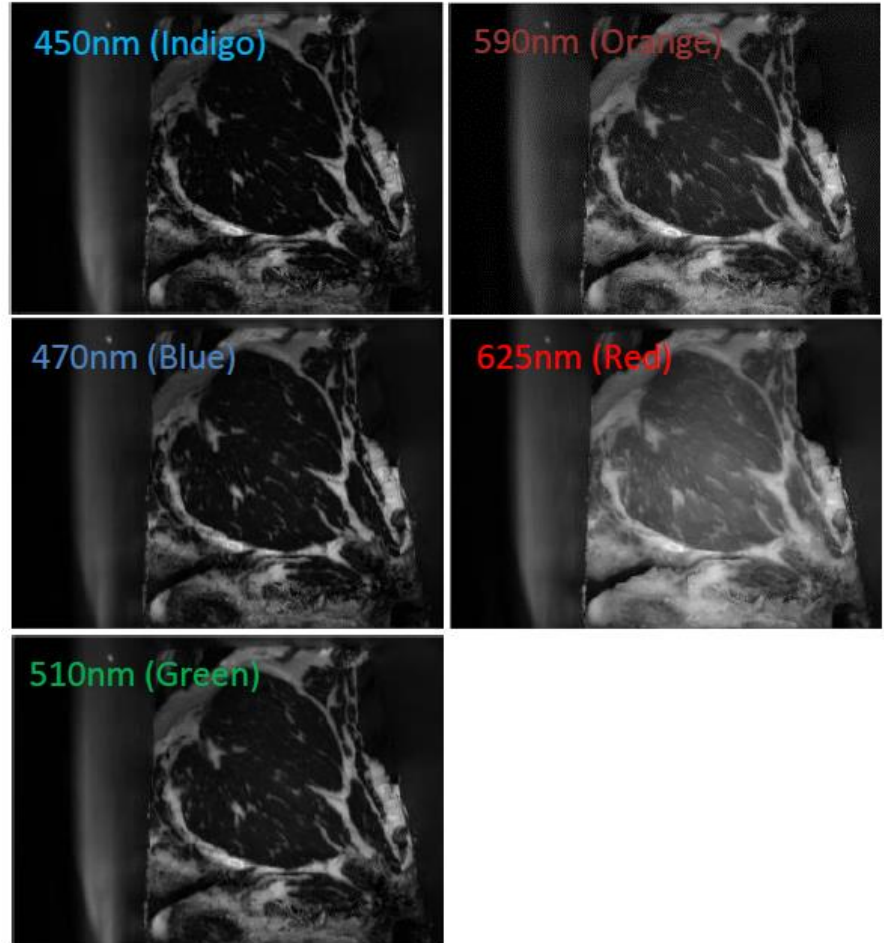
CT

Frontmatec Hyperspectral camera

2 x camera lens



5 x LED
Wavelengths optimised
for meat and fat



Frontmatec Hyperspectral camera

- Trained and validated on approximately 800 carcasses
 - Range in MSA and AUSMEAT traits
 - Range in breed types
 - Grass fed and grain fed
- Independent validation next
- AUSMEAT accreditation and commercialisation

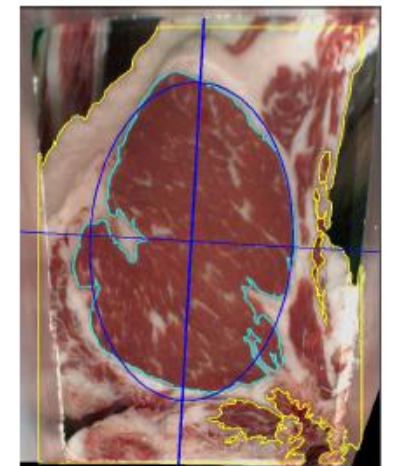
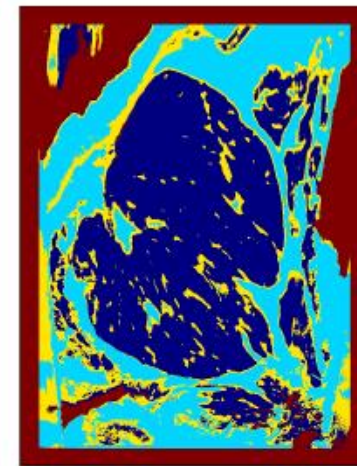
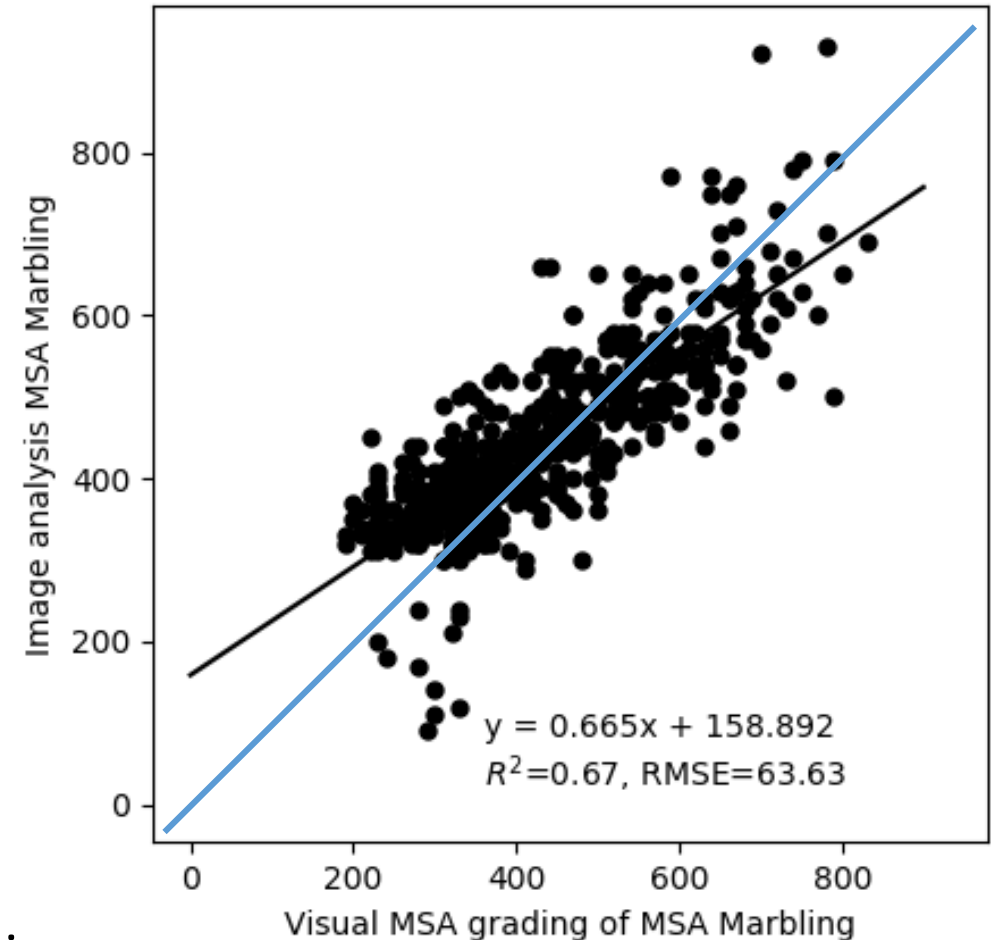


Fig. 3

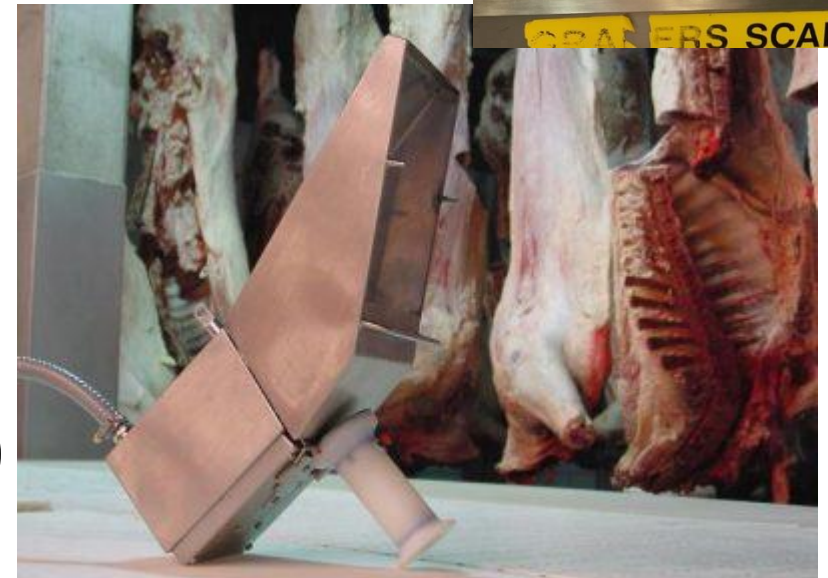
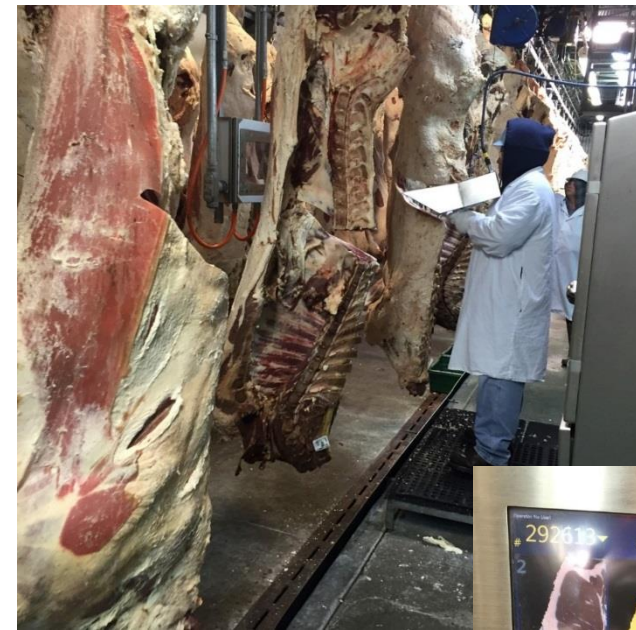
Frontmatec Hyperspectral camera

- Validation precision
 - MSA marbling R2 = 0.67, RMSE = 63.6
- Some inaccuracy (bias) evident
 - Training on humans?
 - Who is right?
- Highly repeatable and reproducible
- Further algorithm development using “perfect images”
 - Determine what errors are linked to carcass presentation
 - Improvements in prediction accuracy



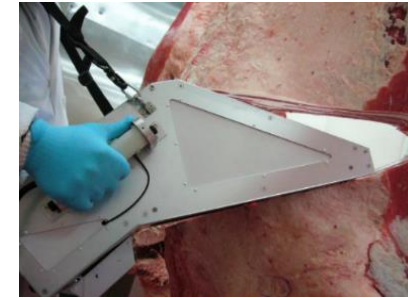
E+V loin eye camera

- Commercially available “grading station” camera
- Installed in commercial abattoirs in Australia
- Outputs “real-time” MSA and AUSMEAT traits
 - Trained/tested on ~ 2000 carcasses
- TEYS Cargill led project
- AUSMEAT accreditation next (prototype)



Meat Imaging Japan (MIJ)

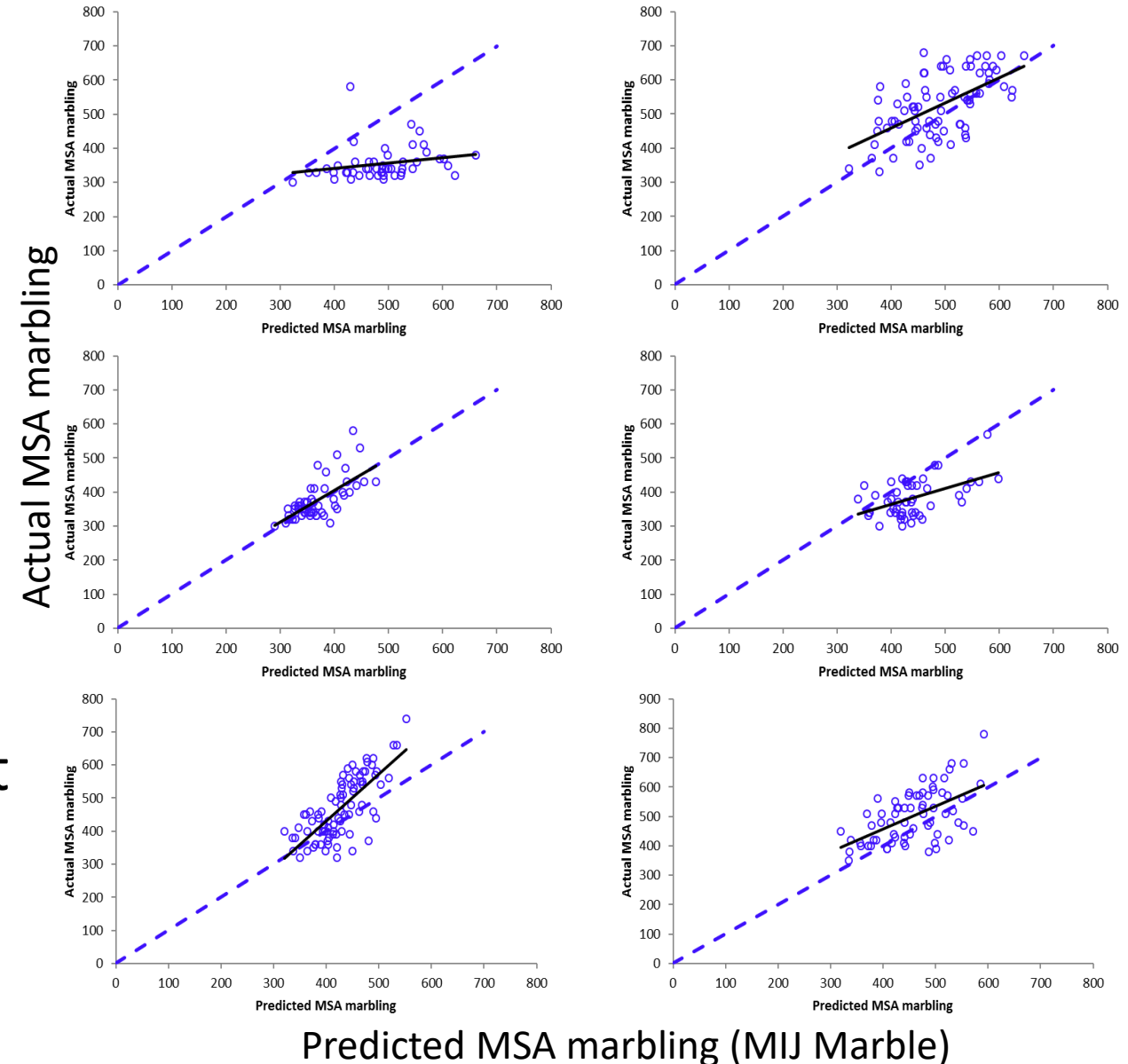
- Used in Japanese Wagyu industry
 - Objective measurement of marbling percentage and distribution
- Multiple prototypes tested in Australia
- Large dataset
 - ~1600 images, 14 experimental groups
 - Multiple breed types – Angus, Hereford and Bos Indicus



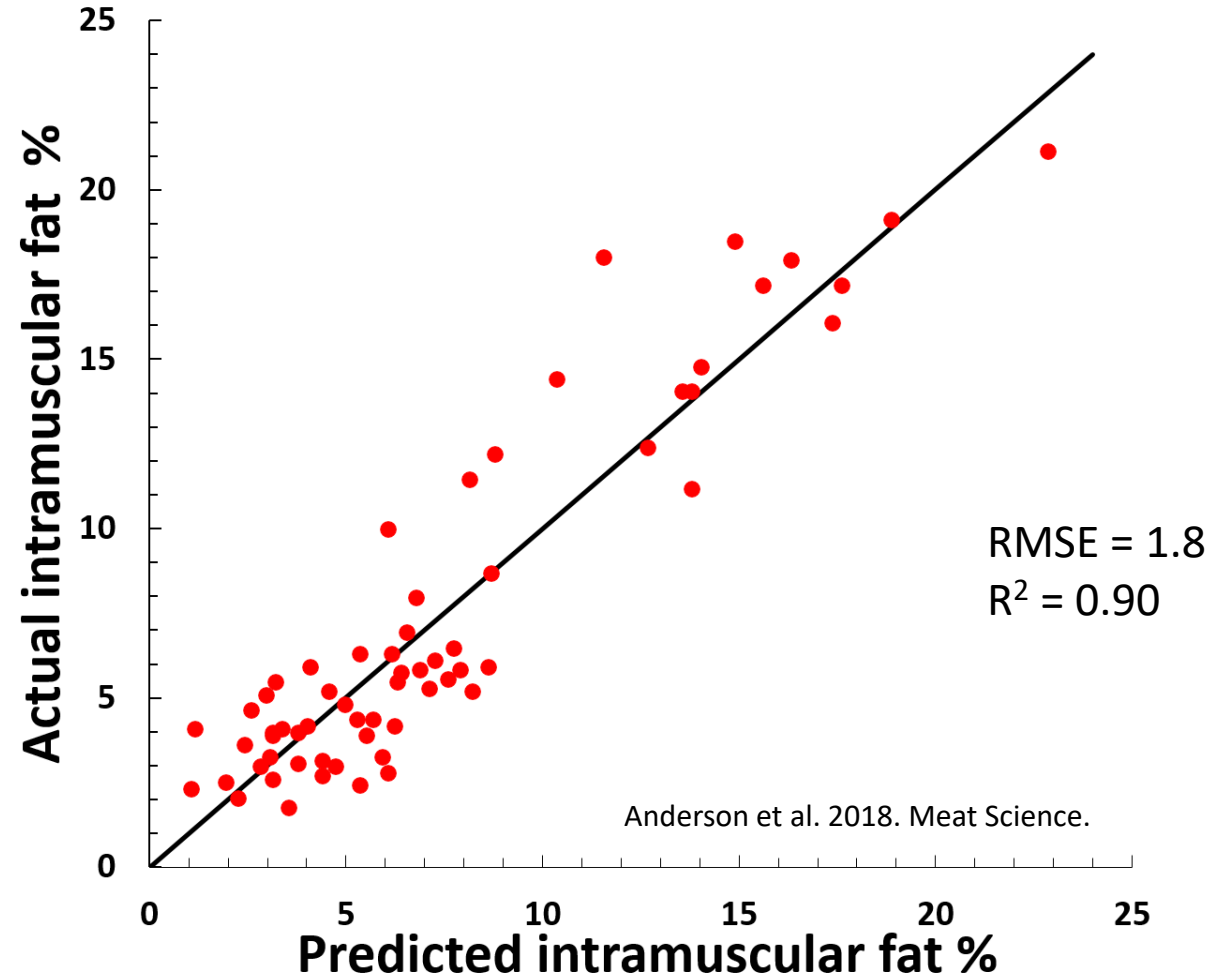
Meat Imaging Japan (MIJ)

Leave one out cross validation analysis

- MIJ marble vs MSA marbling
- Variation in precision and accuracy between datasets
 - Bone dust
 - Carcass quartering and camera position
 - Low IMF
 - Surface moisture
- Optimised fat/lean image segmentation
- MIJ modelling now to directly output MSA marbling
 - Validation analysis pending



Computed Tomography (CT)



Where to next! Chemical Fat%

An alternative to marble score



Where to next! Chemical Fat%!

An alternative to marble score



- Objective measurement trait
- “gold standard trait” to calibrate devices
- Could be used to “normalise” graders marbling scores
- Allows comparison between devices across plants, days, operators

Human graders drift substantially over time

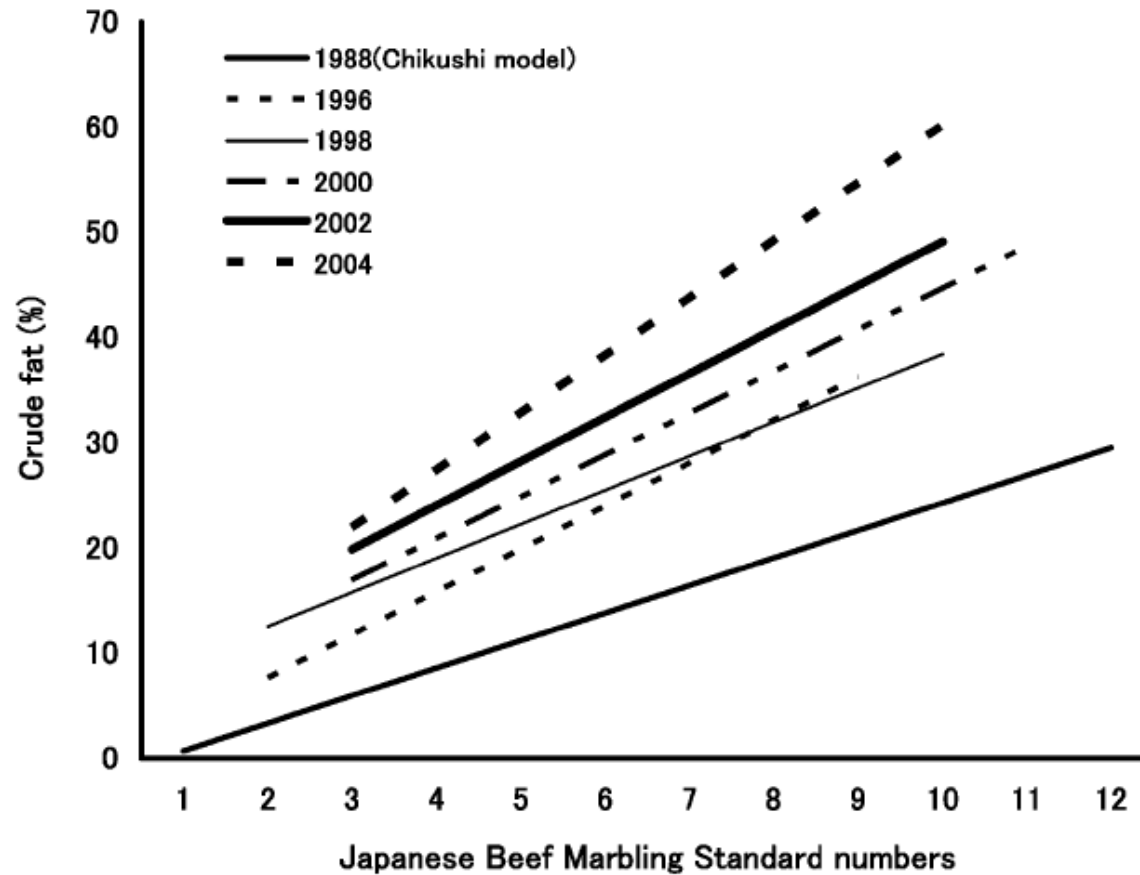
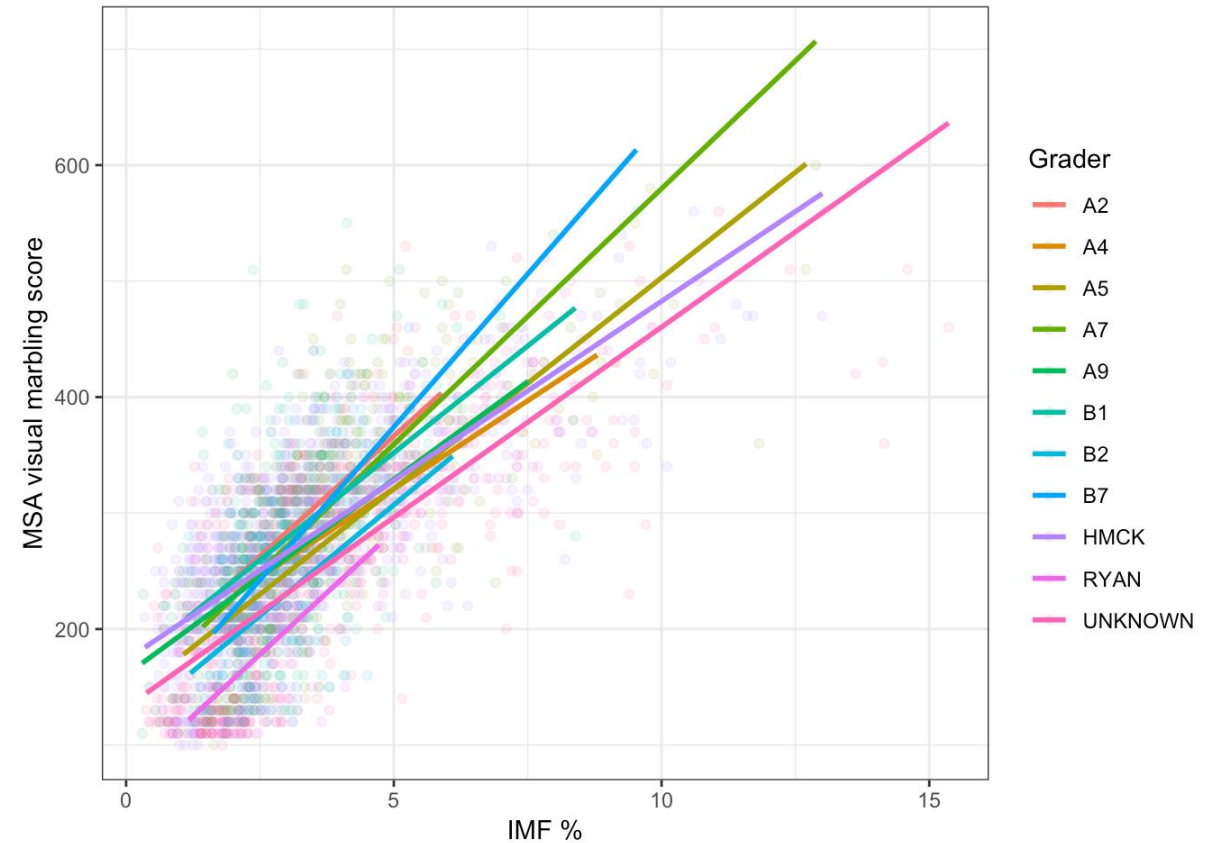
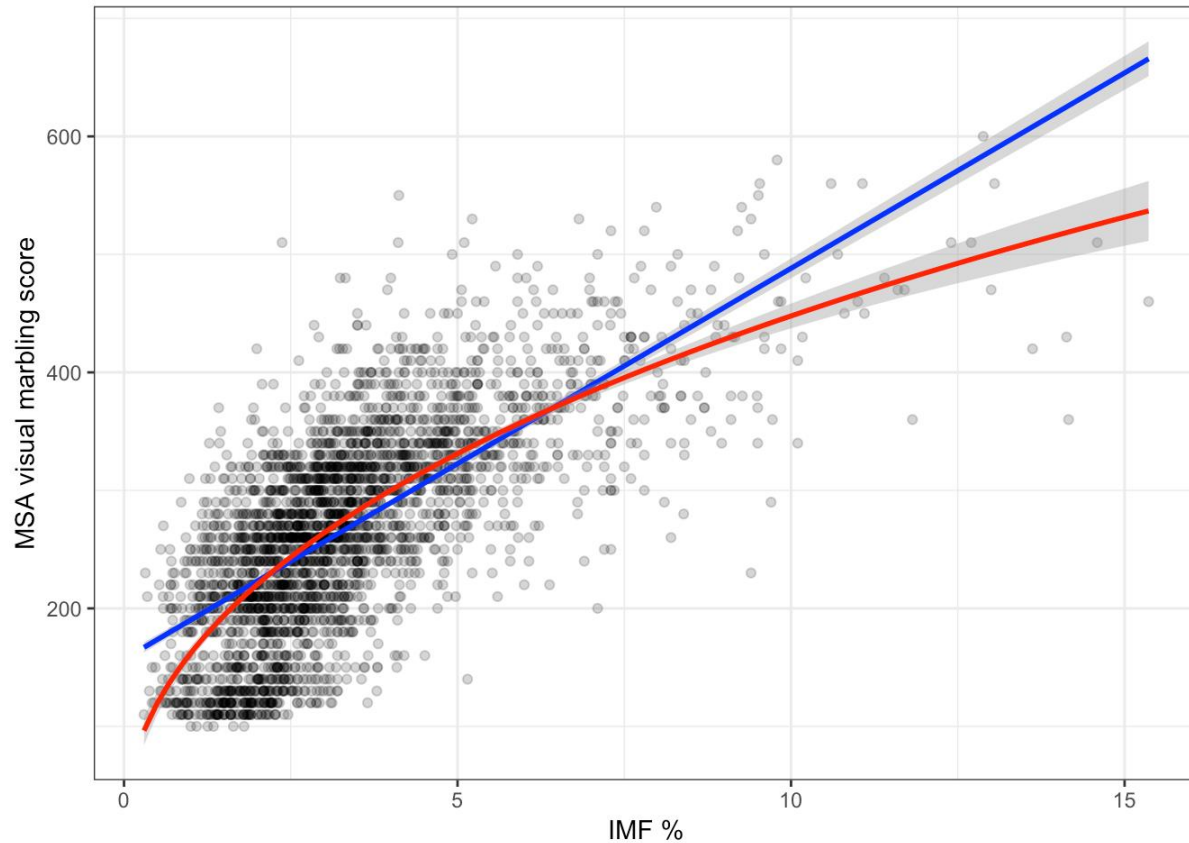


Figure 3 Correlation between Japanese Beef Marbling Standard numbers and crude fat content in the M. longissimus thoracis from Japanese Black steers from 1996 to 2004.

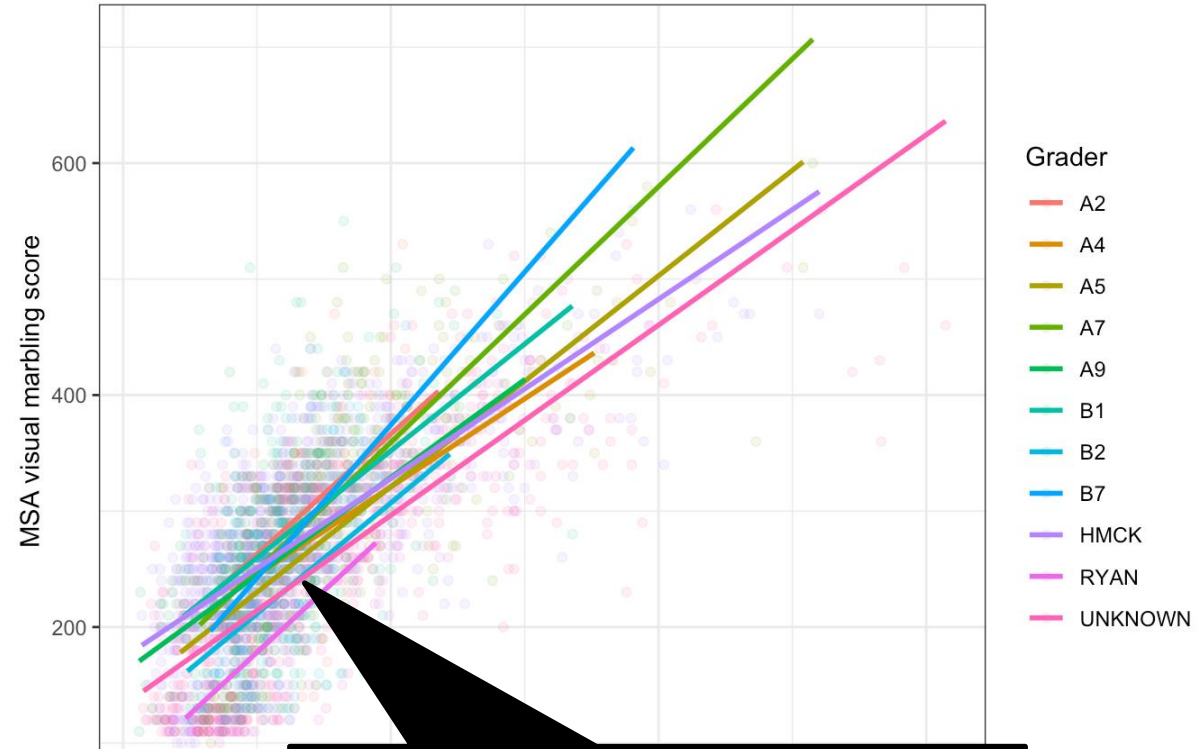
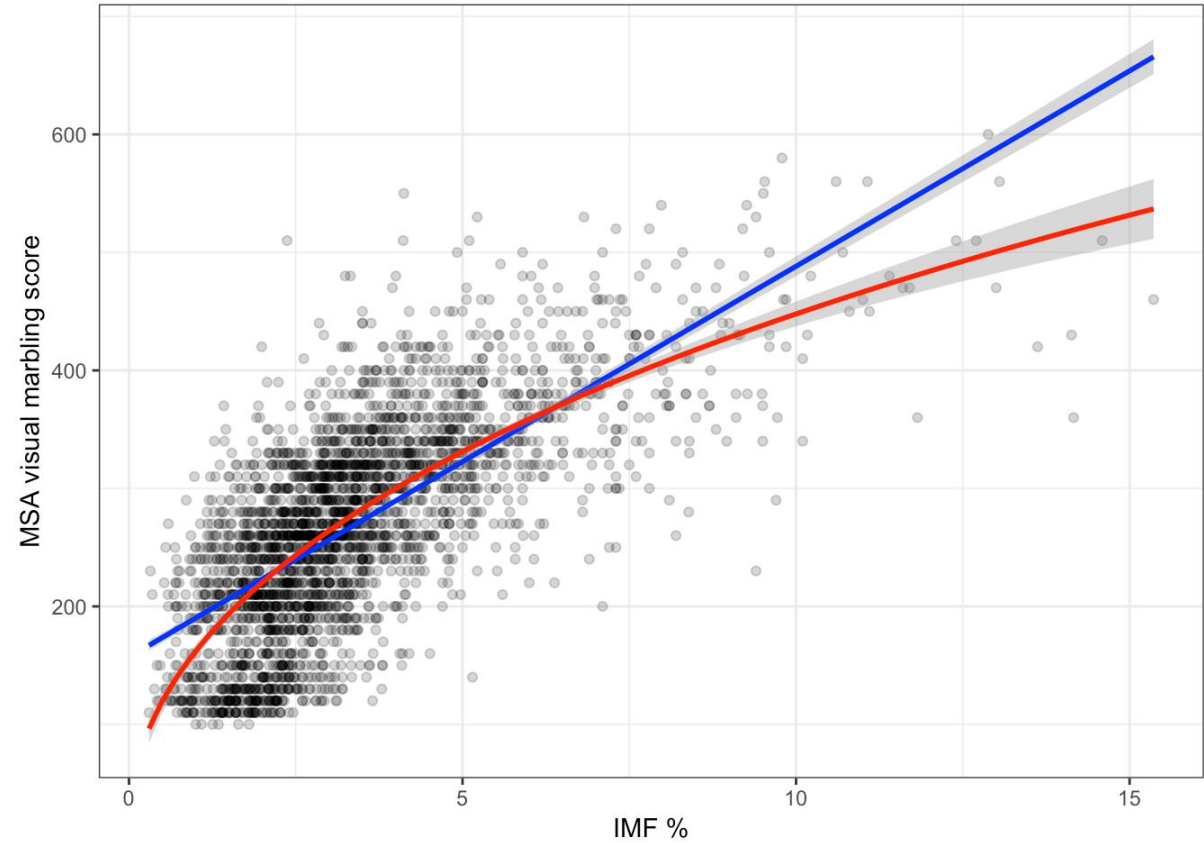
MSA dataset analysis- MSA marble vs IMF%



**Subset of MSA data – limited to STR045, GRL,
14/15 days aged**

- Where most data exists - 3100 observations

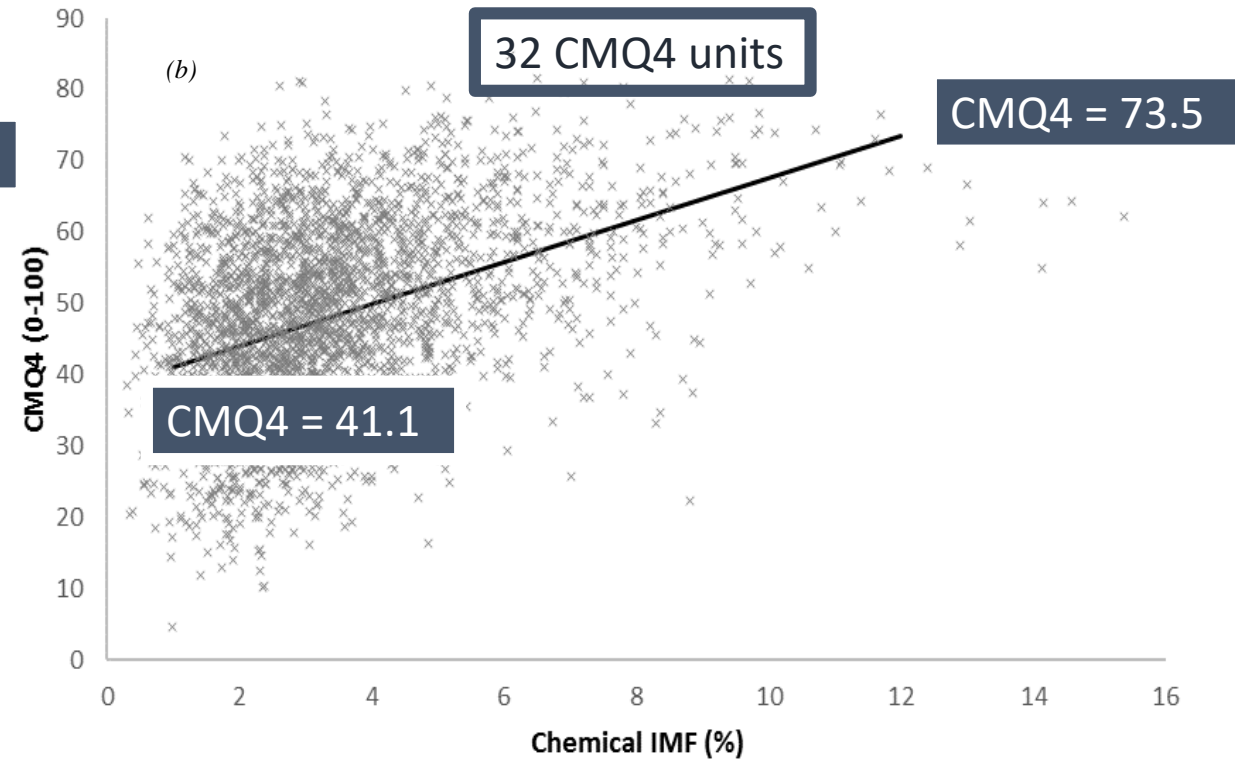
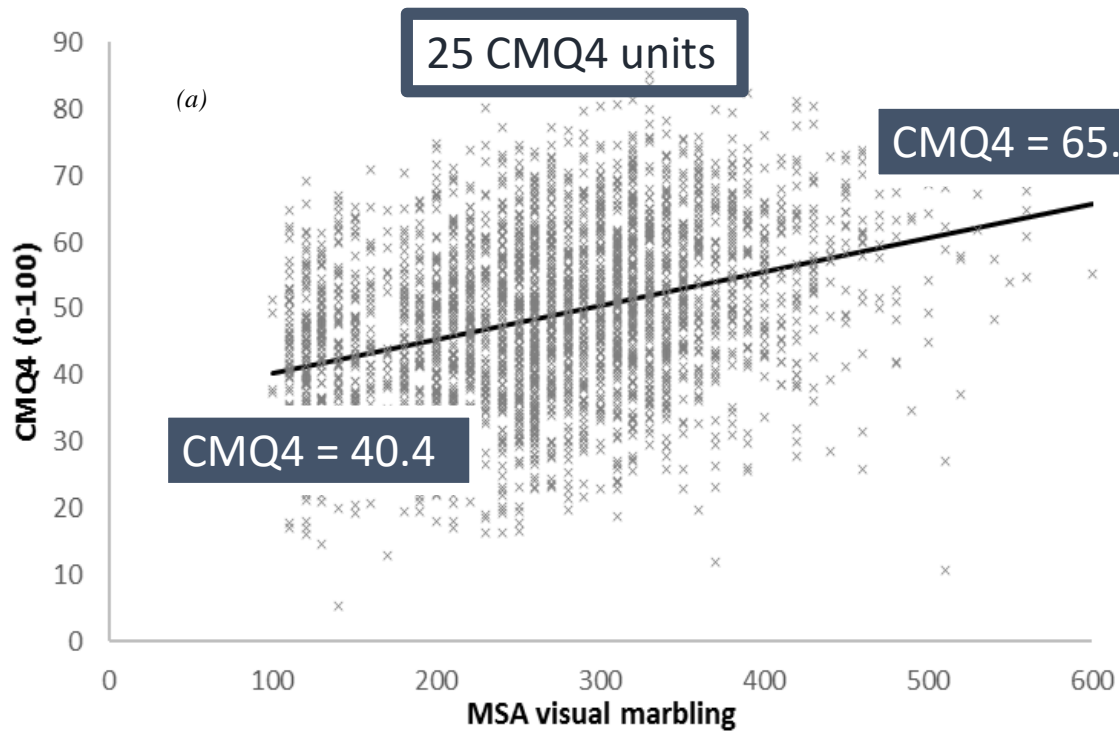
MSA dataset analysis- MSA marble vs IMF%



Subset of MSA data – limited to STR045, GRL, 14/15 days aged
- Where most data exists - 3100 observations

At the same IMF% graders vary in MSA marbling

IMF and Marbling explain eating quality



$R^2 = 0.27$
RMSE = 11.898



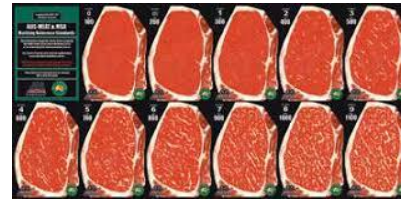
$R^2 = 0.32$
RMSE = 11.737

Chemical IMF% as the calibration trait

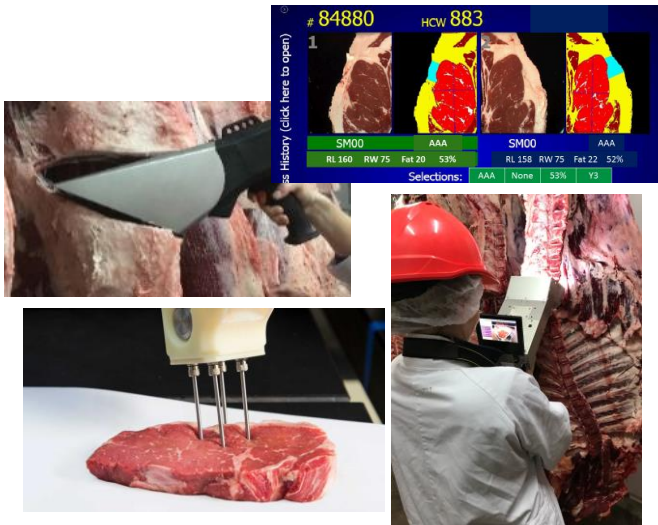
MSA marbling score used in grading data and feedback

Description	Format	Name	Input	?	Aged
Estimated % Bone Indicator	Y or X if doubt	EPBI	0		
Animal Sex Type	MMF	Sex	F		
Moone Growth Fromcast	Y or F 7 9	HGP	0		
MilkFed/Weater	Y/N	MFV	0		
SubYard	Y/N	SYrd	0		
Rinse/Flush	Y/N	RinF	0		
Hot Std Carcass Weight	Weight in Kg	HSCW	350		
HangMethod	T/F/S/L/T/C/D/T	Hang	at		
Hump Height	mm	Hump	63		
Ozification USDA	USDA measure	HOSS	200		
Marbling USDA	USDA measure	MB	300		
RibFat	mm	RbF	10		
Ultimate pH	Metered pH	Ult	5.5		
Loin Temp at Grade	Metered Temp C	Ultmp	0		
Days of Aging from Kill	Days Aged	Age	5		

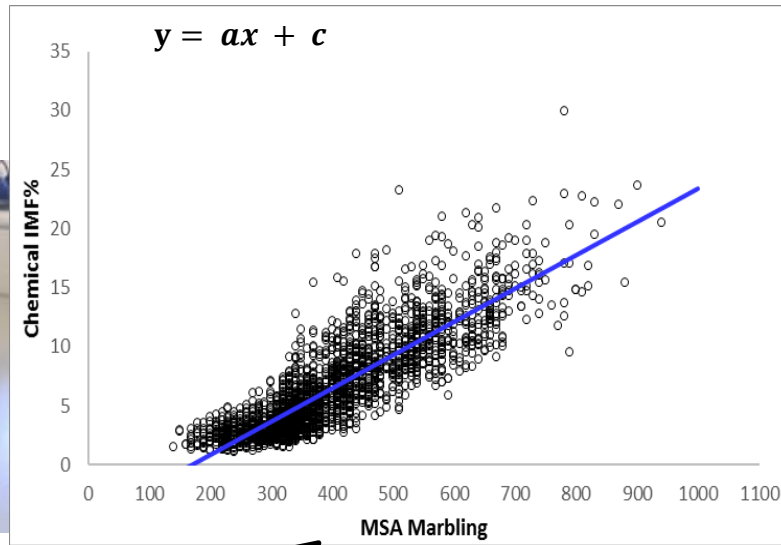
cut/muscle	GRL	RST	SFR	TSL	SCT	CRN
spinalis SPN001	79	69	79	76		
tenderloin TDR024	82	77	76	74		
tenderloin TDR022	78		80			
tenderloin TDR023	79		82	84		
cube roll CUR045	82	82	82	84		
striploin STA045	85	86	88	88		
striploin STP045	83	84	87	87		
Oyster blade OYS036	87	84	89	72		
blade BLD035			43			
blade BLD036	53	57	58	59	59	
chucktender CTF005	49	51	51	53	59	
rump RMP131	51	59	56	62	54	
rump RMP231	54	62	61	60		
rump RMP005	59		67	67		
rump RMP032		52	57	55	56	
knuckle KNU066	46	59	54	58	47	
knuckle KNU069		54	59	56		
knuckle KNU039	36	47	44	51	52	
knuckle KNU000			60	62	56	
outside flat OUF005		40	43	56	59	52
outside flat OUF029			54	61	55	
eye round EYE075	40	44	42	45	46	45
topside TOP001	39		51	53	50	
topside TOP039	40		53	56	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	70	
chuck CHK092			52	56		
thin-flank TFL051			50		50	
thin-flank TFL052			67	59	64	
thin-flank TFL064			61	50	60	
rib blade RIB041			40			
skin FGSkin			45	50	60	30
brisket BRK057			41	49	64	
skin HQskin					60	
intercostal INT037			57			



Devices



Chemical IMF%



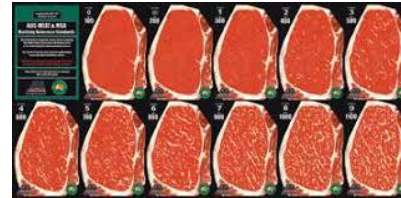
IMF% transformed into MSA marble score using "industry equation"

Chemical IMF% as the calibration trait

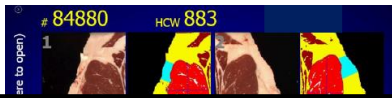
MSA marbling score used in grading data and feedback

Description	Format	Name	Input	?	Aged
Estimated % Bone Indicator	Y or X if doubt	EPBI	0		
Animal Sex Type	MMF	Sex	F		
Monoc Growth Promostat	Y or 7/7	HCP	0		
Milk Fed/Vealer	Y/N	MFV	0		
Sub Yield	Y/N	SYD	0		
Ribs/Flush	Y/N	RbF	0		
Hot Sid Carcass Weight	Weight in Kg	HSCW	350		
Hang Method	T/F/S/L/T/G/D/T	Hang	at		
Hump Height	mm	Hump	63		
Ozification USDA	USDA measure	HOSS	200		
Marbling USDA	USDA measure	UMB	300		
Rib Fat	mm	RbF	10		
Ultimate pH	Metered pH	UPH	5.5		
Loin Temp at Grade	Metered Temp C	UMHP	0		
Days of Aging from Kill	Days Aged	Age	5		

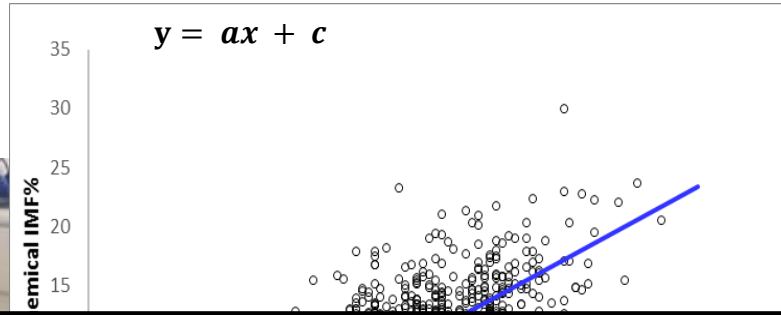
cut	muscle	GRL	RST	SFR	TSL	SCT	CRN
spinalis	SPN001	79	69	79	76		
tenderloin	TDR004	82	77	76	74		
tenderloin	TDR022	78		80			
tenderloin	TDR063	79		82	84		
cube roll	CUB045	82	82	82	84		
striploin	STA045	85	86	88	88		
striploin	STP045	83	84	87	87		
osster blade	OYS036	87	84	89	72		
blade	BLD035			43			
blade	BLD036	53	57	58	59	59	
chuck tender	CTF009	49	49	51	53	59	
rump	RMP131	51	59	56	62	54	
rump	RMP231	54	62	61	60		
rump	RMP005	59		67	67		
rump	RMP032		52	57	55	56	
rump	RMP087		58	54	58	47	
knuckle	KNU066	46	59	54	59	56	
knuckle	KNU099	36	47	44	51	52	
knuckle	KNU100			60	62	56	
outside flat	OUF005		40	43	56	59	52
outside flat	OUF029			54	61	58	
eye round	EYE075	40	44	42	45	46	45
topside	TOP001	39		51	53	50	
topside	TOP039	40		43	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	66	70	
chuck	CHK092			52	56		
thin flank	TFL051			50	59	58	
thin flank	TFL052			67	59	64	
thin flank	TFL064			61	58	60	
rib blade	RIB041			40	58	60	38
brisket	BRK056			42	49	64	
brisket	BRK057			41	49	64	
thin	HQshin					57	
thin	HQshin					60	
intercostal	INT037			57			



Devices



Chemical IMF%



The data systems are already in place!

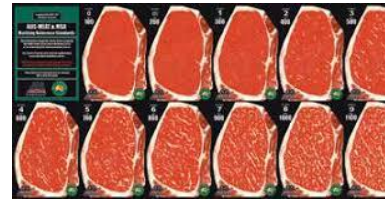
intercostal score using industry equation"

Chemical IMF% as the calibration trait

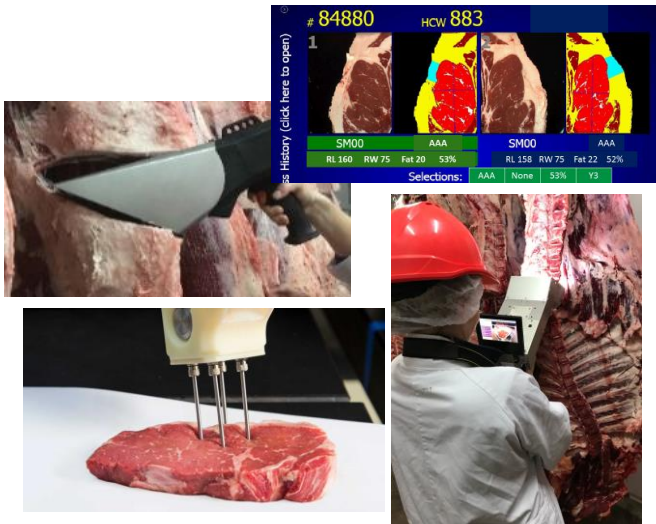
MSA marbling score used in grading data and feedback

Description	Format	Name	Input	?	Aged
Estimated % Bone Indicator	N or X if doubt	EPBI	0		
Animal Sex Type	MF	Sex	F		
Moone Growth Fromcast	Y or F 7 9	HCP	0		
MilkFed/Vealer	Y/N	MFV	0		
SubYard	Y/N	SYD	0		
Rinse/Flush	Y/N	RnF	0		
Hot Std Carcass Weight	Weight in Kg	HSCW	350		
HangMethod	T/F/S/L/T/C/D/T	Hang	at		
Hump Height	mm	Hump	63		
Ozification USDA	USDA measure	HOSS	200		
Marbling USDA	USDA measure	MB	300		
RibFat	mm	RbF	10		
Ultimate pH	Metered pH	Ult	5.5		
Loin Temp at Grade	Metered Temp	LTmp	0		
Days of Aging from Kill	Days Aged	Age	5		

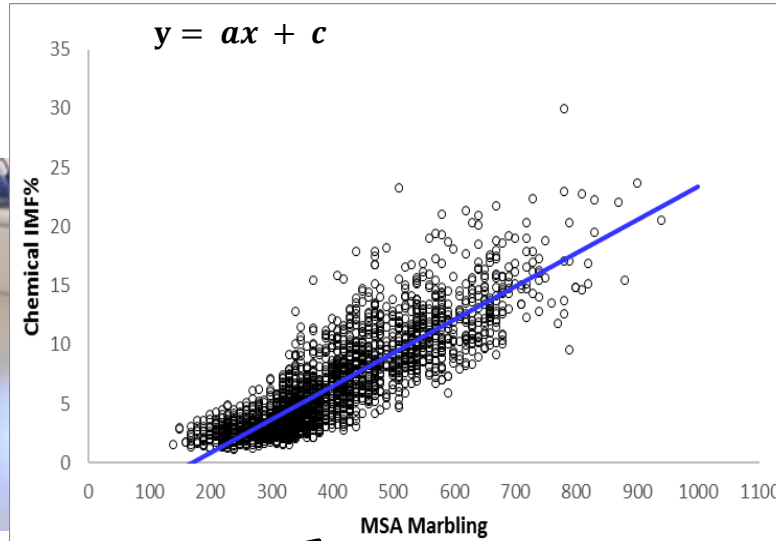
cut	muscle	GRL	RST	SFR	TSL	SCT	CRN
spinalis	SPN001	79	69	79	76		
tenderloin	TDR024	82	77	76			
tenderloin	TDR022	78		80	74		
tenderloin	TDR063	73		62	64		
cube roll	CUB045	62	62	62	64		
striploin	STA045	55	56	58	58		
striploin	STP045	53	54	57	57		
Oyster blade	OYS036	67	64	69	72		
blade	BLD035			43			
blade	BLD036	53	57	59	59	59	
chucktender	CTF005	49	51	51	53	59	
rump	RMP131	51	59	56	62	54	
rump	RMP231	54	52	51	60		
rump	RMP005	59		67	67		
rump	RMP032		52	57	55	56	
knuckle	KNJ066	46	59	54	58	47	
knuckle	KNJ039		52	54	59	56	
knuckle	KNJ039	36	47	44	51	52	
knuckle	KNJ039		40	40	46	46	
outside flat	OUF005		43	43	56	52	
outside flat	OUF029		44	54	61	55	
eye round	EYE075	40		43	45	46	45
topside	TOP001	39		51	53	50	
topside	TOP033	40		53	58	60	
topside	TOP073	34	43	43	56	52	
chuck	CHK068		58	48	53	65	
chuck	CHK074		63	61	67	70	
chuck	CHK078	56	57	58	62	69	
chuck	CHK081		52	60	66	70	
chuck	CHK092		52	56	60	64	
thin-flank	TFL051		59	59	59	59	
thin-flank	TFL052		61	59	64		
thin-flank	TFL064		61	59	60		
rib blade	RIB041		40	58	60	38	
thin	FCSHIN		42	49	57		
bricket	BRB057		41	49	64		
thin	HQSHIN			57	60		
intercostal	INT037			57			



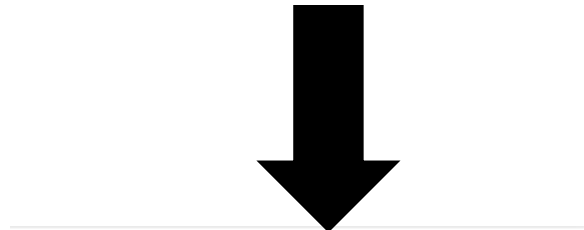
Devices



Chemical IMF%



IMF% transformed into MSA marble score using "industry equation"



But....require AUSMEAT approval first!

AUSTRALIAN INDUSTRY LANGUAGE AND STANDARDS COMMITTEE

Control trade descriptions
Accreditation standards requirements



Approve technologies for use
= INDUSTRY LED!



Retailers and major supermarkets



Australian Government
Department of Agriculture



The Auditor

But....require AUSMEAT approval

firstly

CALIBRATION

VALIDATION

BUSINESS RULES

COMMERCIAL ROLL OUT

REGULATION

Control trade descriptions
Accreditation standards
requirements

Approve technologies for use
= INDUSTRY LED!

The Auditor

AUSMEAT

Summary

- Australian beef industry is investing in the development of grading technologies
- Development of two devices for beef and lamb industry required by mid 2020
- Challenges exist!
- Shift to Chemical IMF for training
- Require AUSMEAT approval to be used for commercial grading and trade
- Disruption to industry minimised by using existing traits and data systems (MSA)

Thank you!



Australian Government
Department of Agriculture



FRONTMATEC



Department of Primary Industries



Department of Agriculture and Food



SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

