Final report

Intramuscular Fat Measurement for Live Sheep

Project code: V.TEC.1730

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Date published: 16 October 24

PUBLISHED BY
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Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

The overall objective of the project is to test a lamb Marbl™ sensor system for the purpose of obtaining live sheep intra-muscular fat (IMF) data.

Milestone 4 of this project covers:
• Data analysis
• Final Report
• Recommendations for future R&D including business case slide deck
• Video footage of the unit in operation to publicly share

Membership of the Steering Group is representatives from MLA and inMR. Invitations may be extended to Farmer/processor partner at any stage as appropriate.

In milestone 3 we reported on the results of trials and testing of two concepts for handling sheep to enable Live Sheep measurement of IMF;
Using a prattley type sheep handler.
A ground based stand for trialling a "shearing" position.

This final report covers feedback on the equipment trials, ideas for future development and analysis of the results from the measurements taken.

Animal Ethics approval been obtained for the trials. This was part of milestone 2.

The project has been completed ahead of schedule.

Executive summary

Background

Nuclear Magnetic Resonance (**NMR**) tools have been used to measure Intramuscular Fat (**IMF**) in carcases, and this project was undertaken to determine if the same technology could be used to measure IMF in live sheep.

Measuring IMF in live animals can assist with developing eating quality characteristics as part of genomic work in the industry. IMF is one of three characteristics currently being used for MSA grading of sheep and if IMF can be measured, managed and developed early in the supply chain then better outcomes can be achieved for processing and branding high IMF (better eating quality) product.

Objectives

The overall objective of the project is to test a lamb Marbl™ sensor system for the purpose of obtaining live sheep intra-muscular fat (IMF) data.

The results of the trial work suggests that with the right materials handling equipment combined with correct positioning of the Marbl™ sensor, it is possible to reasonably accurately measure IMF in live sheep.

Methodology

- Use existing "proven" NMR tools so that the focus is on the application rather than the technology
- Look for examples of good handling systems and try modified versions of these. Two were used – sheep crush and a shearer position.
- Select and trial a range of breeds and both shorn and unshorn to determine if fleece cover impacted system performance
- Small numbers of sheep in the trial and track through processing within a day to enable accurate and fast lab results for comparison

Results/key findings

With good animal handling equipment and accurate positioning of the Marbl™ sensor, measurement of IMF in Live sheep is possible and at a sufficient throughput to make the technology viable.

Benefits to industry

Benefits to the industry include development and confirmation of the genomics around IMF and eating quality. Also if IMF can be identified early in the supply chain, premium products can be developed and processed more effectively.

Future research and recommendations

Based on the results it is recommended that a prototype commercial system be developed to prove the animal handling and to validate the measurements against best practice. A specific smaller system could also be developed purely to enable research in genomics and IMF / eating quality.

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1. Background

1.1 What we were trying to determine

INMR Measure has worked with MLA on applying Nuclear Magnetic Resonance (NMR) technology and have developed the know how to non-invasively measure intramuscular fat in processed Beef and Lamb carcases and has developed what is called a Marbl™ sensor. In discussion with geneticists, there was keen interest to determine if the technology could be used to analyse intramuscular fat (IMF) in live sheep to link in with genetic breeding information. The idea being to assess breeding stock for propensity to produce higher IMF animals. Projects have been completed and successfully demonstrated the technology's ability to measure IMF in Beef and Lamb carcases. A current project is underway to apply NMR technology to live cattle particularly within feedlots to assist in determining the optimum feed regime to produce the best IMF possible. The same applies for Sheep but the challenges to handle the sheep and to locate the sensor are different and unknown. This project will determine what is possible.

1.2 The Value Proposition

The value proposition for recording marble score as an input to the MSA standards is well known for beef and IMF% is an eating quality trait for lamb. The value proposition is that NMR technology can assist to identify and contribute to the genetic selection for optimal eating quality in sheepmeat. Currently technologies are being used to identify and select high IMF lambs in processing plants. If we can identify and select the right breeding stock that consistently produces high IMF meat, then premiums can be obtained in the seedstock and in the meat output.

1.3 Project Scope

The purpose of the project is to explore the feasibility and potential benefits of using Nuclear Magnetic Resonance ("NMR") as a non-invasive method for measuring IMF in Live sheep/lambs, for feedback on farm and for input into the intramuscular fat % (IMF%) field of the MSA sheepmeat index calculator. NMR has been successfully developed by INMR Measure Ltd for use on Lamb Carcases and is currently developing a sensor and system for Live Cattle. INMR Measure's Marbl™ sensor has been used for this work.

Milestone 4 of this project is the final report and covers the overall results, feedback from the testing work and recommendations for a way forward. Specifically milestone 4 includes:

2. Objectives

The overall objective of the project is to test a lamb Marbl™ sensor system for the purpose of obtaining live sheep intra-muscular fat (IMF) data.

The specific objectives of the project were:

- Determine the requirements for measuring IMF% in Live Sheep using NMR (technical application of the technology and practical sheep handling considerations).
- Proof of concept by correlating measurements of IMF from live sheep using Marbl™ with independent benchtop measurements of meat from sheep tracked through slaughter and into boning room.
- Concept design for integrated NMR and sheep handling facilities to enable effective and economic on-farm measurement of IMF including anticipated costings of

commercial unit. As a component of this produce a business case presentation and slide deck for stage two MDC investment and the potential to attract industry partner(s).

3. Methodology

A trial in New Zealand was undertaken to provide proof of concept with a development sensor and basic animal handling equipment. The trial included the following steps:

- Seek and obtain animal ethics approval for the trials
- Sample Selection: A representative sample of live sheep was selected, considering various factors such as availability, breed, age weight and possibly finishing. The primary focus was on ewes.
- NMR Data Acquisition: NMR measurements was conducted on a small batch (50+ animals) of, mostly, recently shorn live sheep using a 'portable' Marbl™ sensor. Several sheep were left "woolly to see if a thicker cover of wool impacted on the outcomes. Suitable animal handling facilities were assessed and two developed sufficient to undertake the trial. Individual animal ID was recorded to enable tracking through to processing.
- Scanning procedure: two methods of holding the animals was trialled
  - one method was to hold the sheep in a sheep crush whilst the sensor was manually manipulated into position. The sensor will be located and held in position for up to 30 seconds or until a measurement reading is obtained.
  - a second method involved having the sensor ground mounted on a frame. The sheep were placed on their hindquarter as if in a shearing position and moved to the sensor and held in position for up to 30 seconds to allow a NMR measurement to be taken. The idea is that a shearer is able to manhandle and position the sheep in a way that is common and familiar when shearing.

  More details of the scanning procedure is included in a "standard operating procedure" which forms part of the animal ethics application. (see Appendix)
- Reference Analysis: InMR worked with the producer and processor to organise collection of samples of meat from tracked animals through to slaughter and into the boning room. LD muscle samples were collected and IMF% analysis undertaken on a proven standard benchtop NMR system.
- Live Marbl™ measurements were to be correlated with benchtop NMR measurements.

4. Results

Results tables are included in appendix.

4.1 Tasks Completed

- Obtained animal ethics approval for the trials
- Research, design, purchase and manufacture sheep handling equipment
- Test and confirm operation of NMR equipment (Marbl™) with handling equipment
- Freight the Sheep handling equipment to the trial farm site
- Assemble, set up and test the trial equipment
- Working with the farm manager, select and prepare by shearing as required, 54 sheep for the trials
- Test preliminary set up using 6 of the sheep
- Complete on site trials using all of the selected sheep (minus a few that escaped)

- Record details of sheep and undertake post trial assessment of equipment
- Track sheep through processing, through the Marble IMF system and collect samples
- Record results of on-site testing of live sheep. Due to the in plant malfunction a physical sample from the loin was collected for all sheep in the trial and subsequently a measurement of IMF derived from a bench top NMR lab analysis.

4.2 Detailed Timeline of activity

Detail of trials and results:

Day 0
Spectrometer and Sensor set up and powered on to enable sensor to get to temperature and stabilise overnight.

Day 1
Prattley Sheep crush set up and positioned at end of race in yards as well as gantry to hold the sensor suspended on a counterbalance set at 40Kgs

Six sheep were put through the crush and the shearing post and ability to position and hold was tested. Crush was less effective than anticipated due to the smaller lambs dropping down and the crush not holding. Crush designed for larger ewes and rams and also for rotating to 90 degrees. We were using smaller lambs and only partially rotating to approx. 40degrees to provide best access for sensor onto spine and loin from directly above. As a result the side “crush” mechanism was removed and replaced with two sets of human hands.

The day was warm and the sensor was exposed to sunshine and as a result went over the set temperature. (temperature was set at 24 degrees – the heater in the sensor can heat up to 10 degrees above ambient but has no cooling – warm ambient temperature combined with sunshine meant the sensor temperature was not able to be brought down to 24 degrees.) As a result no measurements were made and decided to run all at one time the following morning.

Day 2
The sensor was moved from overnight powered on storage and attached to the overhead gantry. Once power was reconnected there was a wait of approx. 30 minutes whilst the sensor temperature returned to 24 degrees.

Sheep were taken through a weigh station, numbered and a live weight recorded. The sheep mob consisted of 54 sheep of various breeds and condition. They were selected from a number of larger mobs from several farms. Breeds were crossbred mostly based on Romney with some Coopworth and Perendale. The majority of the sheep were shorn a week prior and the remainder had approx. 20 mm of wool on them. Due to rain, most sheep were damp to wet.

Sheep were taken from the yard and ran through the crush with the sensor being placed in position with approx. 5Kg’s of weight to establish reasonable positioning. As the person positioning the sensor could not see how the sensor sat on the sheep, one of the people holding the sheep in the crush gave directions to enable better positioning of the sensor over the general loin location. For each sheep we recorded sheep number, weight and any other relevant comments along with the IMF reading provided and the “Signal to Noise” from the spectrometer. After approx. 10 sheep it was decided to increase the number of NMR scans from 4 to 8 to improve the Signal to Noise. 4 scans was taking approx. 4 seconds and the increase to 8 scans at approx. 8 seconds was considered to increase chances of a good measurement and the increase in time did not detrimentally affect the sheep.

Some sheep who had a poor measure or bad position was repositioned and another measurement taken. This was only done with sheep that were not comfortable and showing no signs of stress.

Some sheep took a few seconds to settle but most seemed relaxed and calm especially when the crush was tilted and weight was transferred to their side.

After two mobs were run through the crush the sensor was disconnected and transferred to the "shearing pole" equipment. Since the sensor was powered down the temperature dropped and it took approx. 30 minutes to get the sensor back to the required 24 degrees.

The final mob of 15 sheep were brought out from the race one at a time and held by their forelegs sitting on their rump and held against the sensor. Another person was used to help position the spine / loin in the best position for measurement. Sheep once held by the forelegs and sitting on their rump were calm and seemed settled. No major movement or thrashing was noticed and once released were bouncy and returnd to the mob. Once the race was beginning to empty a few sheep escaped down the side of the race and one jumped over the far end to rejoin the mob. These sheep were left and not measured.

To ensure minimal stress on the sheep, since the sheep had been yarded the previous day, the decision was taken to only run each sheep through once.

Day 3
Sheep were transported to Ovation Gisborne processing facility and split into three yards in number sequence and that sequence was maintained into the slaughter floor. Carcases were tagged and tracked through the slaughter floor including though inMR Marble in line system for IMF measurement. At the grading station, carcase weights, processor id and GR measurements were all noted against the sheep number. Additional labels were attached with the sheep number for easy identification within the chillers.

Day 4
Carcases were tracked from the chiller and through the boning room ensuring the labels were maintained until the loin deboner. At this point approx. 40mm of the anterior of the right loin was cut off and placed in a sample bag along with the identifying label. The samples were stored for IMF measurement within a benchtop laboratory style NMR.

5. Conclusion

Trials conducted provided confidence to the team that live IMF measurement in sheep is possible at reasonable speed given the right materials handling equipment.

Overall system performance and useability:

Preliminary feedback from the team suggests that the crush was the best system and enabled the best positioning of the Sheep for placement of the Sensor. After day 1 we all thought the shearing post was the best contender but after the full trials on day 2 it was unanimous that the crush was the best equipment for the task. Modification will be required to both the sensor and the crush to hold the sheep, make the process more efficient and to enable the sensor to be accurately positioned. Interestingly, IMF accuracy results appear to be better from the "shearer" equipment.

Key findings:

- Marbl™ sensor technology performed well in the environment
- Main modifiation required to the sensor is relocating the electronics box from the end to the top of the sensor – this will make the sensor more compact and easier to position on top of the sheep. In addition the plastic 3D printed enclosure could be replaced with a more robust and easier to clean material such as stainless steel.
- If positioned in the correct position an accurate IMF measurement for Live sheep is feasible therefore accurate positioning is essential
- Sheep need to be recently shorn to ensure sensitive volume is "projected" far enough into the animal to provide a reliable measurement
- Animal handling equipment is key to good positioning and measurement so will need to be redesigned
- Main modification required to the crush is to narrow the sides to improve the hold and to stop smaller lambs dropping down. Also the lead in race can be designed to integrate with a standard race to enable more streamlined flow – this will improve throughput and reduce the animal handling prior to the crush.
- If the business model is a "contract" on farm service model, a trailer mounted system should be designed to allow easy relocation, setup and deployment
- Although the shearer position produced better results and was felt to be better on the day, post evaluation consensus was that the crush had the most potential to incorporate into yards, be easier handling for the operator and with positioning guidance, be a better all round solution. The shearer system was quite hard on the operator and required more manual handling of the sheep. A low cost low throughput system would suit the "shearer" style and may be suitable for research but for a robust, commercial, higher throughput solution, a crush style, designed to allow good positioning of the sensor, will provide a better solution for wider testing such as for seedstock or stud operations

Benefits to the industry:

- Live sheep IMF measurements could be used for seed stock analysis
- Assisting development or confirmation for genomics
- Stud stock analysis
- Further research into the way that IMF is laid down in animals and the impact of different feed regimes on eating quality especially as it relates to IMF
- If fast and cost effective, could be used for sorting and grading animals on farm based on potential eating quality to enable brand differentiation

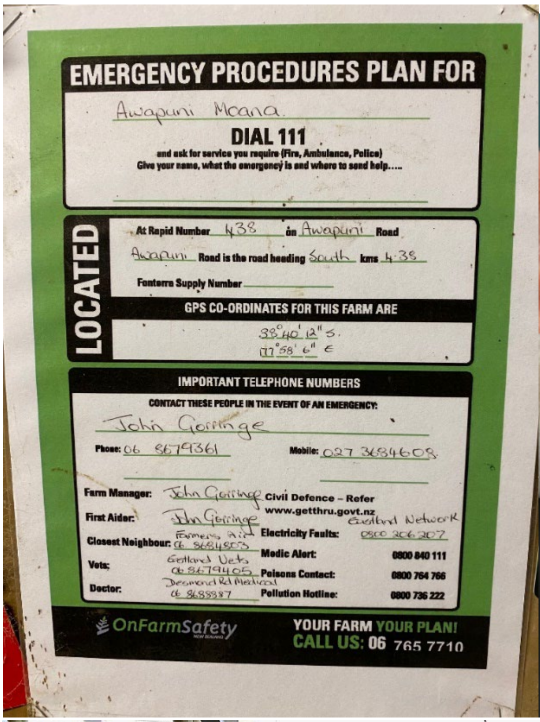
6. Future research and recommendations

Live Sheep IMF measurements can be reliably obtained in the right circumstances. There are two streams of work recommended as an outcome of this project.

1. Research using similar but modified equipment for genomics and for developing understanding of how IMF is laid down over sheep's life cycle and what external factors affect IMF over time in addition to the effect of genetic breeding characteristics
2. If funding allowed and there was interest from researchers, develop and build a "low cost" shearer type system that could be used for low volume / low throughput research. An ideal commercial partner would be an industry group who are looking to grow a premium brand that includes eating quality objectives.
3. Development of a prototype "commercial" crush type system that can be used:

   a. for trials to validate the accuracy limits of IMF measurements using Marbl™
   b. to refine material handling technology to enable fast processing and accurate positioning
   c. to build a robust business case for the technology and it's application
4. Look for a partner to co-invest alongside MLA and inMR. This could be a service provider to the industry such as an existing ultrasound scanning provider or an industry group who are looking to grow a premium brand that includes eating quality objectives.

7. Appendix – Photos and images


EMERGENCY PROCEDURES PLAN FOR
Awapuni Moana
DIAL 111
and ask for service you require (Fire, Ambulance, Police)
Give your name, what the emergency is and where to send help.....
LOCATED
At Rapid Number 438 on Awapuni Road
Awapuni Road is the road heading South kms 4.35
Fonterra Supply Number
GPS CO-ORDINATES FOR THIS FARM ARE
IMPORTANT TELEPHONE NUMBERS
CONTACT THESE PEOPLE IN THE EVENT OF AN EMERGENCY:
John Gorringe
Farm Manager:
Civil Defence – Refer www.getthru.govt.nz
First Aider:
Electricity Faults:
Closest Neighbour:
Medic Alert: 0800 840 111
Vets:
Poisons Contact: 0800 764 766
Doctor:
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Appendix – 7.2 preliminary raw data set

inMR Live Sheep Trial Data from 17 - 20 June 2024

Carcas Ref No.	Carcas id in plant	Method	in Field IMF	in field SNR	# scans	Live Weight	Carcase Weight	GR mm	Comments
1	680	Shear	5.91		4	45.5	20.6	5	
2	681	Crush	12.57	22	4	47	24.1	16	Woolly Ewe
3	682				8	48	23.5	6	
4	690	S	9.19	79	8	46	22.2	8	
5	683				8	47	21.5	4	
6	684	C	6.5	58	8	48	22.5	6	
7	685	C	10.76	41	8	48	22.9	10	
8	686	C	21.6	42	8		21.3	6	Woolly
9	687	Crush	4.64	47	4	50	24.2	17	
10	688	Crush	3	49	4	47	22.1	8	
11	689	C	3.34	48	8	43	20.8	6	
12	691	C	20.54	20	8	47.5	22	8	Woolly perindale Ewe
12	691	C	26.02	20	8	47.5	22	8	Woolly perindale Ewe
13	692	C	10.37	67	8	47	23.1	10	
14	693	C	3.59	33	8	46	22	(3)8	GR 38 but could be 08
15	705				8	44	21.4	10	
16	694	C	5.23	67	8	47	22	8	
17	695	S	8.22	88	8	44	21.5	18	Black Face Ewe
18	696	C	3.93	67	8	48	22.6	7	Ram Lamb
19	697	C	17.2	73	8	48	22.7	9	
19	697	C	12.03	73	8	48	22.7	9	
20	698	C	8.14	36	8	48	22.2	6	Ram Hogget
21	699	C	16.88	9	8	48	22.3	7	
21	699	C	18.23	14	8	48	22.3	7	
22	700	Shear	5.86	81	8	48	23.1	8	
23	701	S	20.01	20	8	50	25	15	Woolly
24	702/703	C	7.53	60	8	47	23.3/21.9	8/5	Duplicate No. - 1x crush & 1x shear
24	702/703	S	1.25	84	8	47	23.3/21.9	8/5	Duplicate No. - 1xcrush & 1xshear (Moving shea
25	704	C	8	38	8		20.2	9	
26	706	C	5.29		4	50	24	17	
26	706	C	11.3		4	50	24	17	
27	707	C	7.98	7	4	48	24.4	7	
28	708	C	7.5	49	8	49	23.1	8	
29	709	C	8.2	35	4	50	25.7	12	Duplicate in field - crush & shear
29	709	S	3.58	84	4	50	25.7	12	Duplicate in field - crush & shear - Ram

inMR Live Sheep Trial Data from 17 - 20 June 2024

Carcas Ref No.	Carcas id in plant	Method	in Field IMF	in field SNR	# scans	Live Weight	Carcase Weight	GR mm	Comments
30	710	C	12.41	82	8	48	23.4	9	
31	716	C	2.32	69	8	47	21.3	7	
32	711	S	15.8	24	8	43	20.3	9	Woolly
33	712	S	11.76	3	8	50	22.9	10	woolly
33	712	S	21.98	16	8	50	22.9	10	woolly
34	713	C	6.9	73	8	46	21.5	8	Good contact
35	714				8	46	20.6	7	
36	715	C	16.6	77	8	44	22	11	
37	717	C	16.26		4	43	22.5	9	
37	717	C	21.1		4	43	22.5	9	
38	718	C	5.13	32	4		21.6	6	
39	719				8	49	22	9	
40	720	C	21.82	70	8	48	22.2	11	
40	720	C	11.8	72	8	48	22.2	11	
41	721	C	7.14	50	8	46	23.3	9	Male black face
42	722	C	25.34	19	8		15.7	5	Woolly Black Face
43	723	S	4.02	83	8	44	20.1	7	
44	724	C	10.34	84	8	46	23.7	15	
45	725	C	2.49		4	40	20.3	10	
45	725	C	5.8		4	40	20.3	10	
46	732	S	5.27	86	8	48	22.8	9	
47	726				8		23.1	9	
48	727	C	9.42	75	8	46	22.3	9	
49	728	S	10.52	86	8	47	22.7	9	
50	729	C	12.18	77	8	47	22.6	15	
51	730	C	3.08	60	8	46	22.2	9	Duplicate - could be 15?
51	730	S	9.11	82	8		22.2	9	Duplicate could be 15? male wether
52	731				8		22.2	8	
58	732	S	4.56	88	8	47	22.8	9	
eyeball'		S	18.4	50					Woolly

(yellow) Took two in field measurements (i.e. ran the system a second time after adjusting animal position

(pink) Possible number misread on farm / in field

Appendix 7.3 “Crush” handling system – excluding woolly lambs

inMR Live Sheep Trial Data from 17 - 20 June 2024

Carcas RefNc	Carcas id in plai	Method	Live Weigh	Carcase Weigh	GR mm	in field SNR	# scan	in Field IMF	Oscar %IMF	lant IF	Meat sample Visual IMI	Comments	Examples Meat with ta	without
31	716	C	47	21.3	7	69	8	2.32	3.74	-1.42	L+			
36	715	C	44	22	11	77	8	16.60	4.31	12.29	L			
26	706	C	50	24	17		4	5.29	4.40	0.89	L			
6	684	C	48	22.5	6	58	8	6.50	4.49	2.01	L			
48	727	C	46	22.3	9	75	8	9.42	4.55	4.87	L			
34	713	C	46	21.5	8	73	8	6.90	4.57	2.33	L+	Good contact		
20	698	C	48	22.2	6	36	8	8.14	4.61	3.53	L	Ram Hogget		
38	718	C		21.6	6	32	4	5.13	4.70	0.43	L			
45	725	C	40	20.3	10		4	2.49	4.77	-2.28	L			
28	708	C	49	23.1	8	49	8	7.50	4.80	2.70	L			
9	687	Crush	50	24.2	17	47	4	4.64	4.86	-0.22	L+			
16	694	C	47	22	8	67	8	5.23	4.87	0.36	L			
18	696	C	48	22.6	7	67	8	3.93	4.94	-1.01	L+	Ram Lamb		
19	697	C	48	22.7	9	73	8	17.20	5.00	12.20	L			
25	704	C		20.2	9	38	8	8.00	5.23	2.77	L+			
37	717	C	43	22.5	9		4	16.26	5.28	10.98	M			
40	720	C	48	22.2	11	70	8	21.82	5.28	16.54	L			
14	693	C	46	22	(3)8	33	8	3.59	5.42	-1.83	L+	GR 38 but could be 08		
29	709	C	50	25.7	12	35	4	8.20	5.64	2.56	M	Duplicate in field - crush & shear		
30	710	C	48	23.4	9	82	8	12.41	5.66	6.75	M+			
11	689	C	43	20.8	6	48	8	3.34	5.70	-2.36	L+			
7	685	C	48	22.9	10	41	8	10.76	5.82	4.94	L+			
13	692	C	47	23.1	10	67	8	10.37	5.82	4.55	L+			
44	724	C	46	23.7	15	84	8	10.34	5.89	4.45	M			
50	729	C	47	22.6	15	77	8	12.18	5.91	6.27	M+			
27	707	C	48	24.4	7	7	4	7.98	6.04	1.94	M			
10	688	Crush	47	22.1	8	49	4	3.00	6.24	-3.24	L+			
41	721	C	46	23.3	9	50	8	7.14	6.85	0.29	M	Male black face		
21	699	C	48	22.3	7	9	8	16.88	7.09	9.79	L+			
24	702/703	C	47	23.3/21.9	8/5	60	8	7.53	6.16(4.91)	#VALUE!	M	Duplicate No. - 1x crush & 1x shear		

Appendix 7.5 “Shearer” handling excluding woolly lambs

inMR Live Sheep Trial Data from 17 - 20 June 2024

Carcas RefNc	Carcas id in plar	Method	Live Weigh	Carcase Weigh	GR mm	in field SNR	# scan	in Field IMF	Oscar %IMF	lant IF	Meat sample Visual IMI	Comments
43	723	S	44	20.1	7	83	8	4.02	4.72	-0.70	L	
4	690	S	46	22.2	8	79	8	9.19	4.94	4.25	L	
17	695	S	44	21.5	18	88	8	8.22	4.95	3.27	L	Black Face Ewe
22	700	Shear	48	23.1	8	81	8	5.86	5.14	0.72	L	
46	732	S	48	22.8	9	86	8	5.27	5.27	0.00	L	
58		S	47	22.8	9	88	8	4.56	5.27	-0.71		
1	680	Shear	45.5	20.6	5		4	5.91	5.53	0.38	L	
49	728	S	47	22.7	9	86	8	10.52	5.87	4.65	M	

Appendix 7.6 All Handling "Woolly" Lambs

inMR Live Sheep Trial Data from 17 - 20 June 2024

Carcas Ref Nc	Carcas id in plar	Method	Live Weigh	Carcase Weigh	GR mm	in field SNR	# scan	in Field IMF	Oscar %IMF	lant IF	Meat sample Visual IMI	Comments
42	722	C		15.7	5	19	8	25.34	5.05	20.29	L	Woolly Black Face
eyeball'		S				50		18.40	5.21	13.19		Woolly
33	712	S	50	22.9	10	3	8	11.76	5.48	6.28	L	woolly
8	686	C		21.3	6	42	8	21.60	5.52	16.08	L+	Woolly
23	701	S	50	25	15	20	8	20.01	5.52	14.49	L	Woolly
2	681	Crush	47	24.1	16	22	4	12.57	5.74	6.83	M++	Woolly Ewe
32	711	S	43	20.3	9	24	8	15.80	6.57	9.23	M+	Woolly
12	691	C	47.5	22	8	20	8	20.54	7.60	12.94	M+	Woolly perindale Ewe

Appendix 7.7 – Male results table

inMR Live Sheep Trial Data from 17 - 20 June 2024

Carcas Ref Nc	Carcas id in plar	Method	Live Weigh	Carcase Weigh	GR mm	in field SNR	# scan	in Field IMF	Oscar %IMF	lant IF	Meat sample Visual IMI	Comments
20	698	C	48	22.2	6	36	8	8.14	4.61	3.53	L	Ram Hogget
18	696	C	48	22.6	7	67	8	3.93	4.94	-1.01	L+	Ram Lamb
41	721	C	46	23.3	9	50	8	7.14	6.85	0.29	M	Male black face

(Yellow) Took two in field measurements (i.e. ran the system a second time after adjusting animal position

Appendix 7.8 -Location diagram

Figure 1. Depiction if where the projected measured area is within a sheep loin.

Figure 2. photo showing optimal positioning of a saddle on the sensor. Notably the spine is positioned into the grove of the sensor enclosure.