final report

Project code: V.RMH.0038

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Date published: 10th June 2016

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 1961
NORTH SYDNEY NSW 2059

DRY AGED LAMB
PROOF OF CONCEPT DEVELOPMENT

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

Executive Summary

In the red meat industry, limited work has been done on the dry ageing of lamb. As lamb has similar physical properties to beef, in that it has a generous outer fat layer covering deep red colored meat, it is indeed peculiar that dry aged lamb has not featured at any level in the food industry.

This project aims to investigate the effect of dry ageing on lamb meat, and if it has any relevance in the food sector.

Lamb of two different fat scores (2 and 4) was dry aged for 35 days at the South Australian Cattle Co. Pty Ltd's state of the art dry ageing facility in the Adelaide Hills. This meat was then tasted at the A Hereford beefstouw restaurant in Adelaide by a panel of food industry professionals (chefs and food writers) against wet aged lamb.

Results of the trial can be summarised as follows:

- Lamb responds to dry aging in a manner resembling beef, in that it has similar positive flavour effects, low microbial growth, and most notably an increase in tenderness.
- A final average difference of 10% yield lost, when comparing dry aged lamb to wet aged lamb,
- Dry ageing of lamb may potentially become sort after food product by chefs.
- Because of the positive flavour impacts of dry ageing on lamb, there is potential upside application for dry ageing lower value sheep meat products such as hogget and mutton.

Dry ageing increases tenderness, roasted and butter flavours, and decreases negative traits such and bloodiness and metallic flavours. There appears to be many potential benefits on expanding dry ageing to beyond lamb, and trial hogget and mutton. Dry Aged Beef tends to attract a 20-30% price premium in retail/restaurants, and it would be entirely feasible that a similar price premium is applied to dry aged lamb. Dry ageing may be able to add significant value to these lower grade sheep meat products.

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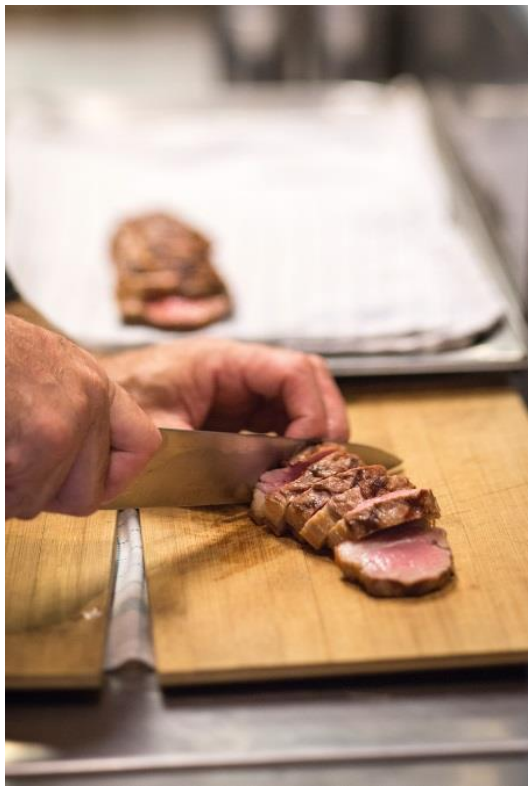


1 Background

The popularity of Dry Aged Beef on restaurant menus and in retail outlets continues to grow as consumer demand for artisan, hand crafted premium food increases. In the red meat industry, this consumer demand has translated into many processors, butchers and restaurants experimenting in the production of dry aged beef.

To date though, limited work has been done on the dry ageing of lamb. Lamb has similar physical properties to beef in that it has a generous outer fat layer covering deep red colored meat. It is thus indeed peculiar that dry aged lamb has not featured at any level in the food industry.

This project therefore aims to investigate the effect of dry ageing on lamb meat, and to see if it has any relevance in the food sector.

This project will showcase preliminary specifications, yields and sensory profiles for proof of concept dry aged lamb along with commentary comparing dry aged beef to lamb process and product development. Lambs at two different fat scores will also be compared for yield and sensory profile.

2 Project Objectives

1. Design and deliver several proof of concept dry aged lamb products and identify key differences to dry aged beef protocols and profiles. Coordinate external laboratory to complete initial microbial assay on the lamb concepts.

2. Evaluate difference between lamb fat scores (ranging from 2 to 4) and cutting lines (i.e sides or primals) in terms of yields, quality and finished product profiles.

3. Present key findings – including yields, process flow chart and specifications, shelf life, menu concepts and indicative costs for various proof of concepts .

3 Methodology

The lamb dry ageing research in this project was undertaken by the South Australian Cattle Co. Pty Ltd, who are a vertically integrated beef business. They are a leading beef producer, dry aged beef specialist, and also own and operate the successful A Hereford Beefstouw restaurants in Adelaide, Melbourne and Scandinavia.

Lamb used in the trial was purchased from Swan Hill Abattoir under their Murray Valley Gold brand. All lamb was killed and processed on the same date.

The trial was conducted at SA Cattle Co's. dry ageing facility at Mt Barker in the Adelaide Hills. Specifications of the dry ageing process were:

Length of Dry Ageing: 33 days

Temperature: 0-2 degree Celsius

Relative Humidity: 70%-80%

Lighting: Aged in the dark with UV Ozone lights

The dry ageing meat was hung from a galvanised steel rail system. The wet aged lamb was aged in cryovac bags in cardboard boxes in the same cool room as the dry ageing meat.

Fat Score 2 and Fat Score 4 lambs, all killed on the same day were cut into primals (forequarter, loin and legs) at the start of the trial. For each Fat Score, 4 x replicates of each primal were aged under two methods. Four replicates of each primal were dry aged, and four replicates were wet aged (vacuum sealed bags).

Each meat sample was weighed at the beginning and conclusion of the trial for yield loss.

At the conclusion of the ageing period, the meat was weighed and then boned out.

Microbial analysis was also taken on the meat at the start and at the conclusion of the dry ageing trial.

After boning and trimming, the lamb was sent via refrigerated transport to the A Hereford Beefstouw restaurant in Adelaide, where it was cooked for the tasting trial.

All meat cuts were grilled to a medium rare level, with no seasoning or oil used. The tasting panel consisted of 15 food industry experts (chefs and food media) who tasted each piece of meat and recorded their results.

The different lamb cuts were coded and tasted by the sensory panel, who were asked to score in intensity the lamb based on a variety of flavours on a score sheet. For purpose of this trial, the flavour parameters used were adapted to Lamb flavours from the Beef Flavour Lexicon (from the Research Guidelines for Cookery, Sensory Evaluation and Instrumental Tenderness Measurements of Meat and Development of a Beef Flavor Lexicon and its Application to compete Flavor Profiles and Consumer Acceptance of Grain- and Pasture Finished Cattle).

4 Results

4.1 WEIGHT LOSS AND YIELD DATA

LAMB DESCRIPTION			WHOLE PRIMAL			TRIMMED ANALYSIS		
CUT	**FAT SCORE**	**AGEING TYPE**	**AVERAGE START WEIGHT (kg)**	**AVERAGE FINAL WEIGHT (kg)**	**AVERAGE WEIGHT LOSS**	**AVERAGE BONED OUT WEIGHT (kg)**	**AVERAGE TRIM/BONE WEIGHT (kg)**	**AV YIELD FROM STARTING WEIGHT (%)**
LOIN	2	Wet Aged	2.70	2.70	0.0%	0.71	1.99	26.2%
LOIN	4	Wet Aged	2.93	2.93	0.0%	0.81	2.12	27.7%
LOIN	2	Dry Aged	2.62	1.91	30.7%	0.55	1.41	20.4%
LOIN	4	Dry Aged	2.74	2.08	25.2%	0.55	1.51	20.0%
LEG	2	Wet Aged	3.52	3.52	0.0%	2.36	1.16	67.0%
LEG	4	Wet Aged	3.60	3.60	0.0%	2.45	1.15	68.1%
LEG	2	Dry Aged	3.76	3.32	10.8%	2.19	1.07	58.8%
LEG	4	Dry Aged	3.51	3.05	11.7%	1.94	1.11	55.3%
FOREQUARTER	2	Wet Aged	3.91	3.91	0.0%	1.81	2.10	46.2%
FOREQUARTER	4	Wet Aged	4.16	4.16	0.0%	2.24	1.92	53.4%
FOREQUARTER	2	Dry Aged	3.82	3.11	17.7%	1.52	1.57	40.4%
FOREQUARTER	4	Dry Aged	3.91	3.24	16.6%	1.52	1.77	38.3%

FIGURE 1. SUMMARY OF WEIGHT LOSS AND YEILD ANALYSIS

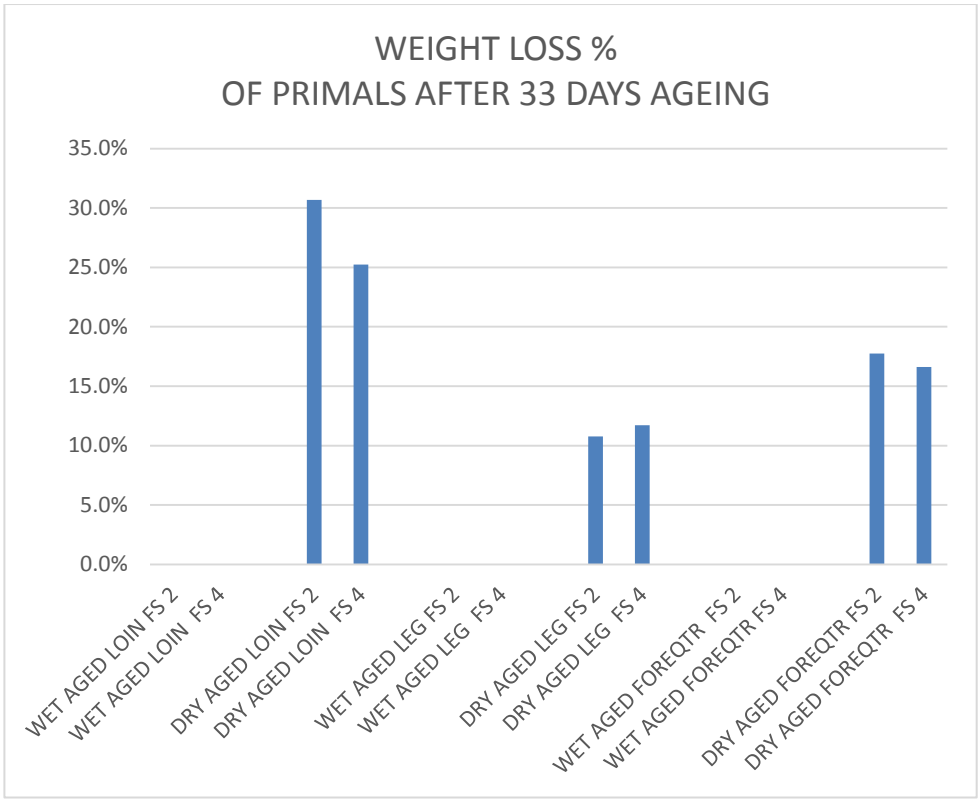


FIGURE 2. WEIGHT LOSS OF LAMB AFTER 33 DAYS AGEING

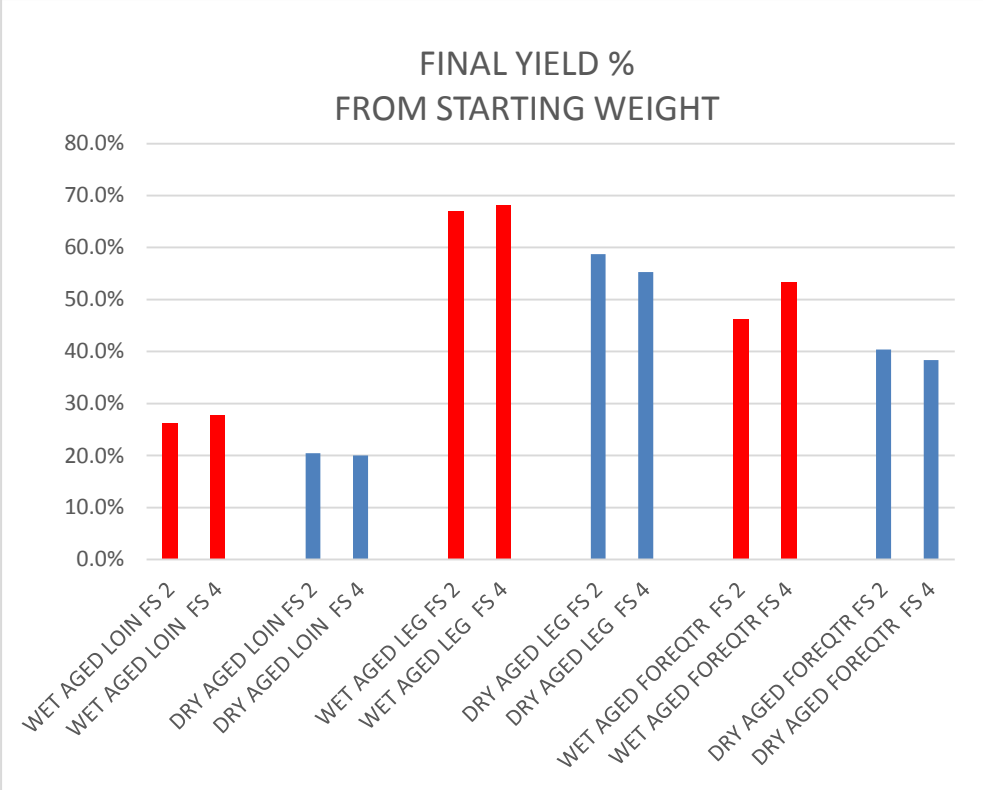


FIGURE 3. FINAL YIELD OF PRIMALS AFTER BONING AND TRIMMING

4.2 MICROBIAL DATA

FIGURE 4. Microbial Analysis of FAT SCORE 2 LAMB

SAMPLE & LRN 200cm^2 area swabbed	TVC cfu/per cm^2		E.coli cfu/per cm^2		Yeast cfu/per cm^2		Mould cfu/per cm^2		Pseudomonas cfu/per cm^2		Salmonella cfu/per cm^2	
DAYS DRY AGEGING	**0**	**33**	**0**	**33**	**0**	**33**	**0**	**33**	**0**	**33**	**0**	**33**
LEG	69	14	ND**	ND**	1.25	0.25	ND**	0.75	ND**	ND**	ND**	ND**
LOIN	800	ND*	ND**	ND**	10	ND**	1.25	ND**	ND**	ND**	ND**	ND**
FOREQUARTER	51	2	ND**	ND**	5.6	ND**	ND**	ND**	ND**	ND**	ND**	ND**

FIGURE 5. Microbial Analysis of FAT SCORE 4 LAMB

SAMPLE & LRN 200cm^2 area swabbed	TVC cfu/per cm^2		E.coli cfu/per cm^2		Yeast cfu/per cm^2		Mould cfu/per cm^2		Pseudomonas cfu/per cm^2		Salmonella cfu/per cm^2	
DAYS DRY AGEGING	**0**	**33**	**0**	**33**	**0**	**33**	**0**	**33**	**0**	**33**	**0**	**33**
FOREQUARTER	61	ND*	ND**	ND**	3.1	ND**	ND**	ND**	ND**	ND**	ND**	ND**
LOIN	1780	2.5	0.125	ND**	ND**	ND**	ND**	ND**	ND**	ND**	ND**	ND**
LEG	3300	ND*	ND**	ND**	45	ND**	ND**	ND**	ND**	ND**	ND**	ND**

Note * - Not detectable <2.5 /cm^2

Note ** - Not detectable <0.25 /cm^2

4.3 SENSORY DATA

FIGURE 6. Lamb Forequarter
Fat Score 2 Wet Age vs Dry Age

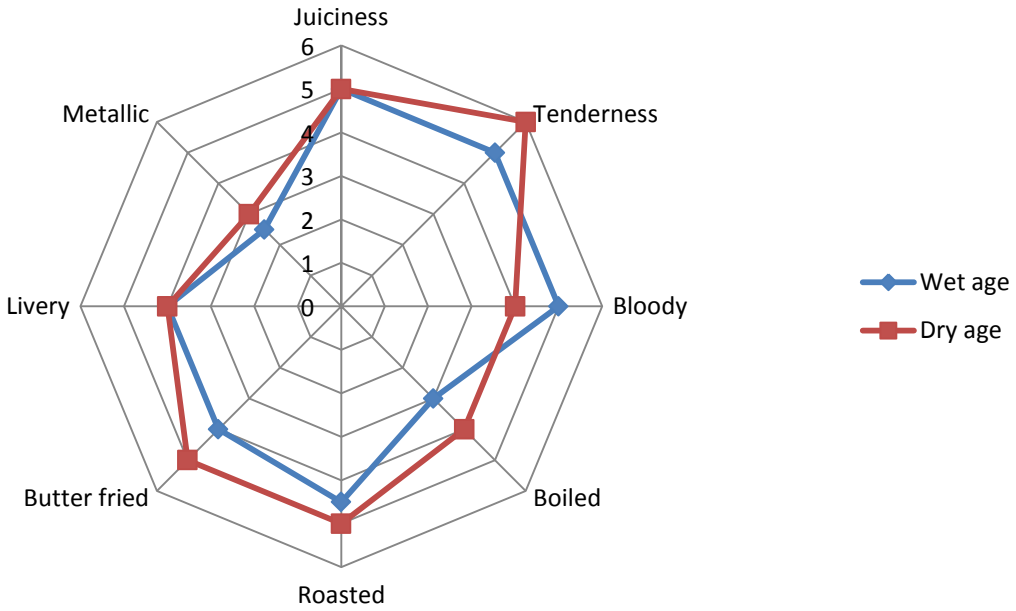


FIGURE 7. Lamb Forequarter
Fat Score 4 Wet Age vs Dry Age

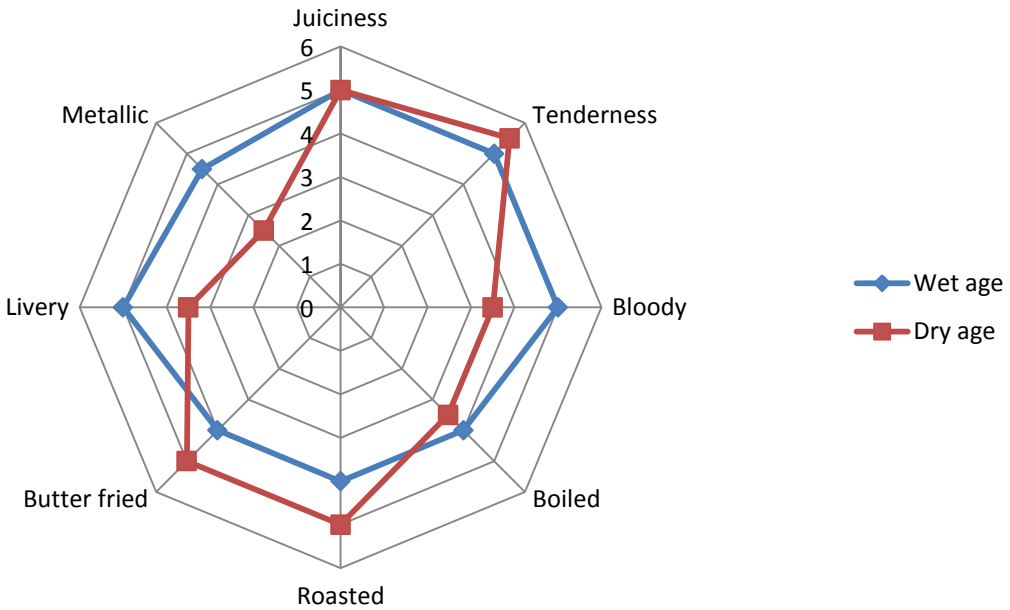


FIGURE 8. Lamb Loin
Fat Score 2 Wet Age vs Dry Age

FIGURE 9. Lamb Loin
Fat Score 4 Wet Age vs Dry Age

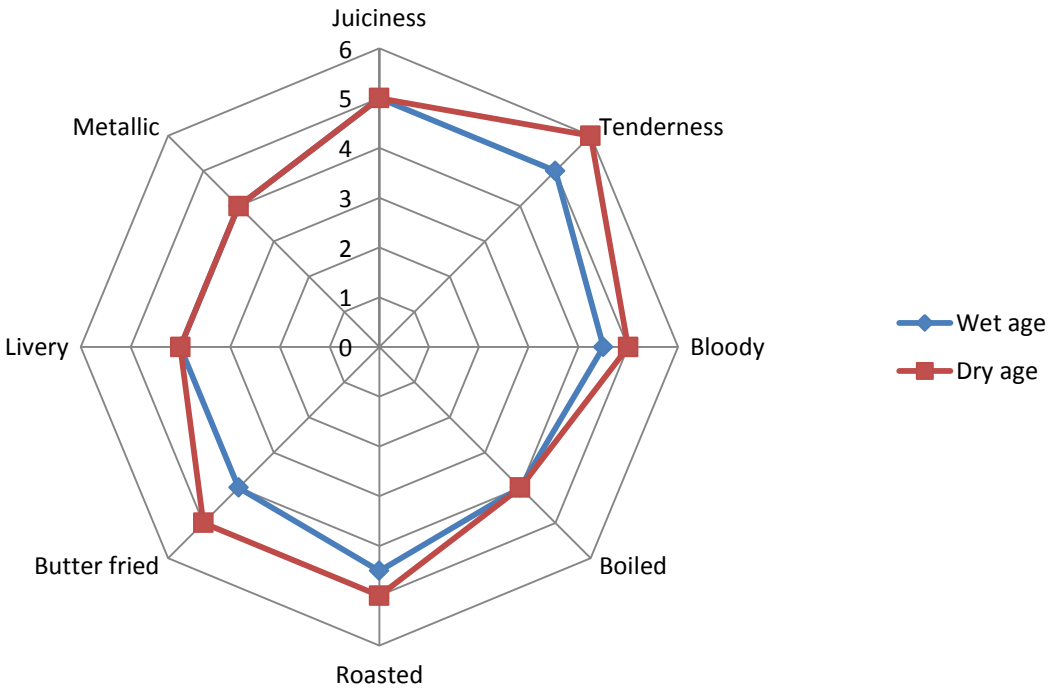


FIGURE 10. Lamb Leg
Fat Score 2 Wet Age vs Dry Age

FIGURE 11. Lamb Leg
Fat Score 4 Wet Age vs Dry Age

5 Discussion

5.1 WEIGHT LOSS AND YIELD

As expected, there was no sgnificent weight loss on the wet aged lamb primals, besides the small purge naturally found in wet age product. This is due to the lamb being encased in a vacuum sealed bag that did not allow the transfer of atmosphere between the inside and the outside of the bag.

In the dry aged lamb, there was a significant difference in the weight loss between the three different primals, but a much less significant weight difference between the two different type of fat scores of 2 and 4.

One of the theory's this trial aimed to test was that lambs of higher fat score would be more suited to dry ageing, as the increased fat cover would prevent excessive shrinkage/weight loss during the dry ageing process. Figure 2 demonstrates the difference in weight loss between Fat Score 2 and Fat Score 4 primals (Forequarter, Loin and Leg).

The only significant difference in weight loss between fat scores was observed in the loin cut. Fat score 2 lambs averaged 30.7% weight loss over 33 days compared to the Fat Score 4 Lamb loins that lost 25.2%. This is a 5.5% difference in weight loss. Considering that the loin is the most valuable cut on a lamb body (approximate price of $11.50/kg, untrimmed), this results in the cost price of the Fat Score 2 loin being $1.22/kg more than the Fat Score 4 loin. The results between the loin cuts strongly indicate the fat score 4 lambs are better suited to dry ageing from a yield perspective.

There was a much less significant difference in weight loss between fat scores 2 & 4 on the forequater and legs of lamb.

The fat score 2 forequarters lost 1.1% (130 grams) more weight than the fat score 4 forequarters. Overall the fat score 2 forequarters lost 17.7% in weight and the fat score forequarters lost 16.6% weight.

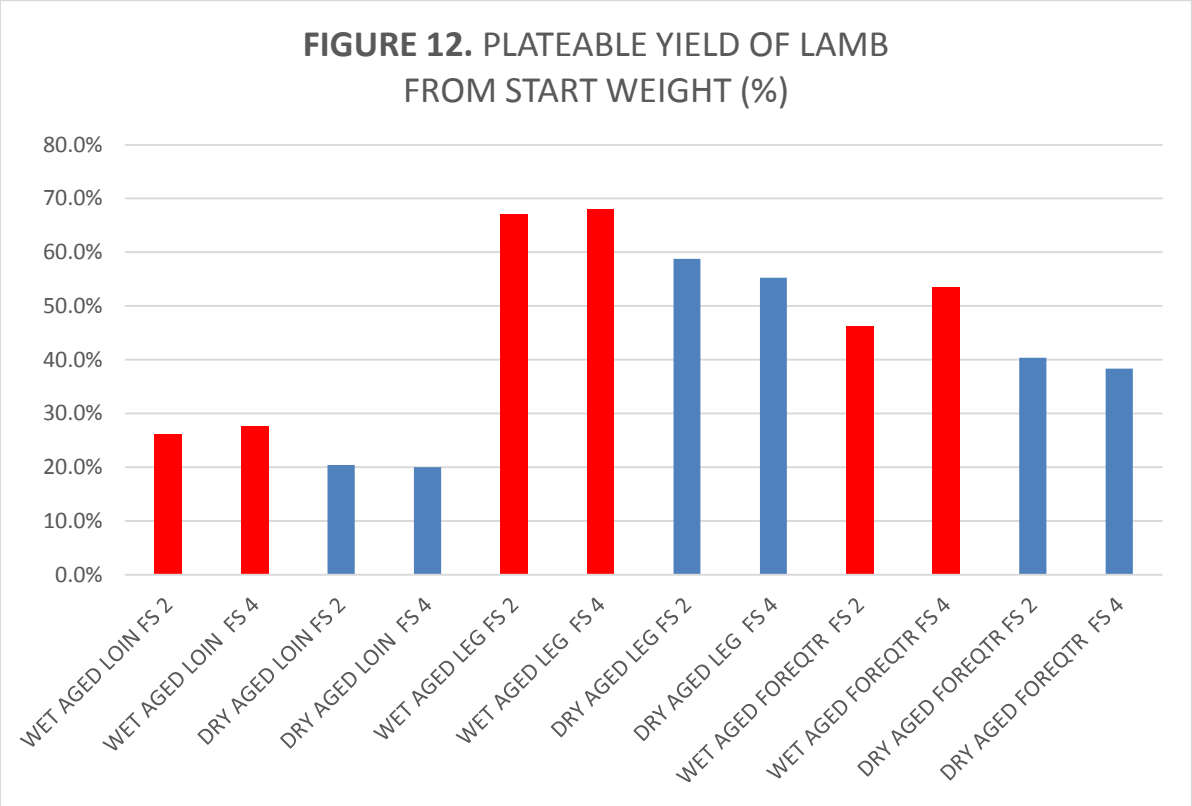
In the legs, the fat score 4 legs (11.7% weight loss) actually lost slightly more weight than the fat score 2 legs (10.8% weight loss). This was an average weight difference of 0.9% or 270 grams.

When looking at the overall weight losses in the lamb across 33 days, the results are significantly higher than what we typically experience in beef. Beef will usually lose between 9-12% of its starting weight over a 35 day dry ageing period. The average dry ageing yield losses across all lamb fat score were as follows:

Forequarter:	17.2%
Loin:	27.9%
Leg:	11.2%

If simply looking at weight losses in isolation from any other parameter (particulary in the loin), these results indicate that dry ageing lamb would be borderline unviable. Losing 27.9% in yield before trimming is extremely high and is of economic concern. The lamb leg however, appears to be the most suitable from a yield loss perspective for dry ageing, as it is in-line with the losses experienced with beef dry ageing.

However, when comparing final plateable meat, the results are quite interesting. The differences between the wet and dry aged lamb are not as great as expected. Figure 12 below summarises the weight loss of wet aged vs dry aged across the different primals.



The average difference in plateable yield (calculated from the start weight at the beginning of the trial to the final plateable yield) of the wet aged lamb over the dry aged lamb is summarised below. It would have been expected, based on the weight losses of the dry aged lamb (for example, dry aged loins averaged a 28% weight loss) that the final plateable yield of the dry aged lamb would be in line with the average weight loss. However, this is certainly not the case.

AVERAGE PLATEBALE YIELD DIFFENCE BETWEEN WET AND DRY AGED LAMB

Forequarter:	10.4%
Loin:	6.8%
Leg:	10.5%

But why is the plateable yield difference between the two ageing methods not as great as the difference in the weight loss between the two ageing methods? After all, the dry aged lamb has some significant shrinkage losses after 33 days.

It may possibly be explained by the fact that when dry ageing occurs, it is not a uniform drying process across the entire piece of meat. The outer fat layers of the meat dry out first, forming a hard crust like surface. This protects, and essentially traps in the moisture in the high quality meat underneath. As a result, the weight loss in dry aged lamb primarly occurs in the parts of the primal that would ordinarily be trimmed off a wet aged lamb primal before plating up. This is a significant finding, meaning that the initial economic based concerns pertaining to excessive yield losses when dry aged lamb may not be as significant as first thought.

5.2 MICROBIAL ANALYSIS

Visually, the lamb behaved extremely similar to beef in terms of the rate of change (outer drying) and the physical appearance of the meat during all stages of the dry ageing process. No mould growth was observed on the dry ageing lamb at any time during the dry ageing process.

The microbial analysis of the dry aged lamb is extremely encouraging in terms of its suitability for dry ageing.

Total Viable Count (TVC) reduced significantly during the dry ageing process. TVC Counts as high as 3300 cfu/per cm^2 were observed on the meat at the beginning of the trial, and by the end of the 33 days, TVC was either Not detectable or negligible (only 3 samples recorded a presence of TVC , with the highest TVC being 14 cfu/cm^2.

Yeast followed a similar pattern to TVC. Yeast counts dropped significantly from the start of the trial to the end of the trial. In fact, all bar one sample records an absence of yeast after 33 days, with the one positive sample recording only 0.25 yeast cfu/per cm^2.

Mould was also absent (besides a negligible recording in one sample at the beginning, and at one sample at the end of the trial).

Salmonella and pseudomonas were both absent at the start and the end of the trial.

Most microbes require moisture to survive, hence the rapid and effective drying of the surface during the dry ageing process, as evident by the virtual absence of any microbes on the surface of the lamb, strongly indicates that lamb is suitable for dry ageing in terms of safety for human consumption. It is worth noting that the facility in which the lamb was dry aged was a state of the art purpose built room. Thus replication of these results will vary between dry ageing facilities, depending on the level of sophistication of the facility, starting raw material and processing hygine during and after the process.

5.3 SENSORY ANALYSIS

The major findings of the sensory anaylsis by the tasting panel are summarised below.

DRY AGED LAMB SIGNIFICANT OBSERVATIONS

1. TENDERNESS

   One of the most commonly used and desired descriptors of lamb is in reference to its tenderness. Therefore the tenderness sensory results of this trial are of high relevance.

   The dry aged lamb was ranked more tender in 4 out of 6 sets compared to the wet aged lamb. In the other 2 out of 6 sets the tenderness scores were identical.

   In addition, 4 out of the 6 sets of dry aged lamb were given a maximum rating for tenderness.

   It therefore appears that the increase in tenderness that is associated with dry aged beef also occurs in dry aged lamb. This is a significant finding.

2. BUTTER/FRIED

   The butter/fried character was used to describe the richness and palate weight of the meat samples, and is considered a positive attribute associated to dry aged meat.

   In 5 out of 6 sets, the dry aged lamb was rated higher in Butter/fried characters.

3. ROASTED

   The roasted flavour was also seen as a positive flavour attribute as it contributes to overall richness and depth of flavour.

   In 4 out of 6 sets, the dry aged lamb was rated higher in roasted flavour compared to the wet aged lamb.

WET AGED LAMB SIGNIFICANT OBSERVATIONS

1. JUICINESS

   In 2 out of the 6 sets, the wet aged lamb was considered more juicy by the sensory panel. In the remaing 4 out of 6 sets, the juiciness ratings were the same as the dry aged lamb.

   The slight increase in juciness of wet aged lamb can probably be explained by the fact that dry ageing slightly reduces the moisture content of the meat. This is a similar effect to what is found in dry aged beef.

2. BLOODY
   Blood flavours in lamb would be considered a negative flavour description, and thus not desirable in dry aged meat.

   In 4 out of the 6 sets, the wet aged lamb was considered more bloody.

3. METALLIC
   Metallic flavours in lamb would also be considered a negative flavour description, and thus not desirable.

   In over half of the sets (3 out of the 6), the tasting panel found the metallic characters to be stronger in wet aged lamb.

Overall, it appears from the results of this trial, that dry ageing of lamb has positive flavour impacts on the meat – that being, it enhances some of the desirable flavour characters such as tenderness, roasted and butteriness, and reduces negative flavour descriptors such as blood and metallic. The only positive flavour descriptor where wet aged lamb came out in front was in juiciness, although the observed difference was only very minor.

6 Conclusions/Recommendations

The results of this trial are extremely positive in terms of the beneficial impact that dry ageing has on lamb. We have observed the following key points:

- Lamb is suitable for dry ageing from a microbial and food safety perspective.
- Lamb dry ages in a very similar way to beef, although the weight losses as a percentage of the starting weight are higher (and in the case of loins, significantly higher). This is due to the higher surface area to volume ratio in lamb over beef.
- The plateable yield of dry aged lamb is less than wet aged lamb – although the difference is much less than first expected compared to the weight losses experienced during dry ageing. This can be explained in that the trimming of the dried up meat was mostly concentrated on the parts of the lamb that would otherwise also be trimmed off in wet aged lamb.
- Dry ageing of lamb has many beneficial flavour impacts, most notably in tenderness, roasted and buttery flavour.
- Dry Aged Lamb could sell for a significant premium over wet aged lamb. Dry Aged Beef tends to attract a 20-30% price premium in retail/restaurants, and it would be entirely feasible that a similar price premium is applied to dry aged lamb.

In summary, the only major negative outcome found in this trial was the weight loss of the high value loin cuts during dry ageing. It is worth considering though, that in this trial the lamb was dry aged in it primals. This approach was to ensure that dry aged primals of lamb could be directly compared to the same wet aged pieces of lamb (as it would have been impossible to directly compare dry aged lamb sides against a vacuum sealed whole side of lamb as we could not vacuum seal a full side of lamb). We predict there would be a significant reduction in weight loss of the lamb if it was dry aged as a whole side, as the surface area:weight ratio will be lower.

In order to investigate further reductions of weight losses during dry ageing, we recommend that another lamb dry ageing trial take place, but only concentrated on the dry ageing whole sides of lamb. It would be expected that overall weight losses would be significantly reduced as there is less fresh meat surfaces cut open, and exposed to dry ageing.

We also see some potential application of dry ageing on lower value sheep meat products. Since dry ageing increases tenderness, increases roasted and butter flavours, and decreases negative flavours such and bloodiness and metallic – then there appears to be many potential benefits in using dry ageing on not just lamb, but on hogget and mutton. Dry ageing may be able to add significant value to these lower grade sheep meat products.