Final report

LAMBPRO Resource Flock

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Prepared by: Tom Bull
LAMBPRO Partnership

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Meat & Livestock Australia Limited
PO Box 1961
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Abstract

The LAMBPRO Resource Flock project is split into two areas; maternal and terminal. The eighth and final milestone relates to data analysis as well as the development of maternal and terminal index's, from the data collected previously in this project.

The LAMBPRO Maternal Resource Flock is one of the first maternal resource flocks specialising in self-replacing maternal genetics. In 2015, a reference flock of 543 ewe lambs by 17 sires was established. A further 157 ewe lambs resulted from the 2016 lambing, representing approximately 700 potential ewe lambs in the project. The performance of these daughters from 23 sires, was tracked using DNA parentage, for two seasons, to gain further understanding of what drives profitability in varying climatic regions of Australia.

Milestone eight focuses on developing an economic model to renew the current LAMBPRO$ index. The objective of developing the new index, is to better encapsulate the profit driving traits across varying environmental regions of Australia. The ability to better understand profit in varying regions of Australia will have a significant impact by fine tuning breeding, specific to areas and markets.

Over the last three years, the LAMBPRO Terminal Resource Flock has enabled LAMBPRO to test and identify sire lines which have the capacity to produce highly marbled lamb. It has highlighted the variance in meat quality not only amongst terminal breeds, but also within terminal breeds. Using the data collected throughout this project, LAMBPRO has been able to establish an eating quality index, which places a great amount of selection pressure on consumer satisfaction, whilst incorporating yield.

Executive summary

The Australian sheep flock has changed significantly in composition over the past decade; it has become a highly ewe dominant flock. The proportion of prime lambs produced by specialist maternal genetics, has also greatly increased. There is growing evidence that modern maternal genetics perform differently to traditional terminal, merino and first-cross systems. Additionally, INF/RF data, supported by industry observation, suggests that the South Down breed may perform well for IMF. As consequence, the LAMBPRO Resource Flock was established to address these two industry problems.

The project was split into two; maternal and terminal. To address the terminal aspect of the project, three cohorts of slaughter lambs from terminal genetics were produced (~700 lambs). Sire and slaughter progeny were DNA tested, and loin samples were collected for IMF, SF5 testing and consumer sensory testing. All data collected was submitted to LAMBPLAN. Initially, the first cohort included South Down and Dorset terminal sires. Hampshire Down genetics were also included in the project in the second and third cohort of the lambs. The Hampshire Down genetics consistently came out on top for both IMF and consumer satisfaction.

To address the maternal aspect of the project, four different commercial sheep production environments were selected to mate (using artificial insemination) approximately 1,750 ewes to 35 different composite maternal sires with the aim of producing 600-700 daughters. The objective of the project was to mate daughters twice to composite maternal sires and record numerous production traits. This was achieved on three of the four different sites. However poor A.I. results, resulted in one of the sites being discarded from the project. From the data collected over the two mating seasons, an economic modelling process was implemented to improve estimation of economic parameters which underpin selection indexes. The investigation included looking at the need to vary index weightings to achieve the best outcome under varying production environments.

There has been a number of key messages arise from this project since inception in 2015. First and foremost, the use of commercial enterprises to run maternal progeny testing is a difficult process. The attention to detail required to get not only the A.I.program right, but data collection as well, is often too difficult for large scale commercial producers. Looking at the data, the highest ram for NLW produced the most lambs 154%, and the lowest NLW ram produced the least lamb 78% However an important difference to note, was there was a 70% difference in weaning percent; highlighting the impact of using known genetics. The other major impact was the relationship between turn off weight and number of lambs weaned. The highest ranked ram for fertility, had one of the lowest two year old weaning weight per ewe joined. The key message here is fertility is extremely important in self-replacing maternal models, but milk and early growth is just as vitally important to ensure lamb survival and optimal weaning weights.

Since completion of the project, we have analysed our internal LAMBPRO data, and have made significant change to our own sire selections, with more emphasis being placed on milk and growth. The development of the new LAMBPRO 5 index has reinforced this through economic modelling by Next Gen Agri, which favours sheep that can turn off lambs early, not simply have large litter sizes, with little ability to turn them off. The benefit of these findings and key messages will filter through to the projected 950,000 lambs to be bred by LAMBPRO genetics in 2020.

The LAMBPRO Terminal Resource Flock project has and will have a profound impact on lamb in

Australia. The project began looking at Poll Dorset, and Southdown sheep, and over time included the Hampshire Down. This inclusion saw the discovery of the leading marbling genetics in Australia, from a breed that had little to no performance data, or had little inclusion in previous information nucleus projects with the Sheep CRC. Since the first inclusion of Hampshire Down genetics, a significant number of rams were included from the Hampshire Down breed and as a breed they have been unparalleled. This finding has been the catalyst for the commencement of a lamb brand based on the Hampshire Down genetics. Lamb has been trialled by leading Middle East, Chinese, and domestic markets with significant interest. In 2021 the first commercial shipments of lamb will commence to these markets. The future for a premium high IMF (>7%) is real, and all on the back of progeny testing as part of this project.

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1 Background

The Australian sheep flock has changed significantly in composition over the past decade with a decrease in the proportion of wethers creating a highly ewe dominant flock, and an increase in the proportion of prime lambs produced by specialist maternal genetics. There is growing evidence (B.LSM.0039 – Potential Industry Impact: Management of non-Merino ewes; B.LSM.0064 – Lifetime Maternals – development of management guidelines for non-Merino ewes) that modern maternal genetics are performing differently to traditional terminal, merino and first-cross systems. Additionally, INF/RF data, supported by industry observation, suggests that the South Down breed may perform well for IMF.

1.1 Purpose

This project focuses on terminal sire eating quality and composite maternal prime lamb production systems which will complement the Resource Flock and the current weight of R&D on traditional terminal, merino and first-cross prime lamb production systems.

There are two components to this project:

1.1.1 Terminal Sires

a). Generate carcase phenotypes to complement Resource Flock data to improve benchmarking of South Down terminal sires for eating quality.

b). Provide DNA for high density genotyping of sires and progeny, and phenotypes to complement RF data, to contribute to building reference populations for SNP association analysis

1.1.2 Maternal Sires

a). Generate 600-700 ewes representing c.35 industry sires that are well linked and will contribute to Resource Flock and LAMBPLAN datasets

b). Mate these ewes twice to generate reproduction and production phenotypes to:

1). Improve accuracy of breeding values for maternal composite sheep,

2). Inform economic modelling to improve estimation of economic parameters that underpin selection indexes.

This will include investigation of the potential need to vary index weightings to achieve the best outcome under different production environments.

c). Generate carcase phenotypes to compliment Resource Flock data to improve Breeding Value Services.

2 Project objectives

2.1 Terminal sire project

1). Produce two cohorts of slaughter lambs (100-150 head) from Poll Dorset, South Down-Poll Dorset and South Down sires.
2). Collect sire and slaughter progeny DNA for testing.
3). Collected loin samples for IMF and SF5 testing.
4). Collect loin samples for sensory testing.
5). Provide all data for inclusion in the Resource Flock database for further R&D and, as appropriate, inclusion in routine LAMBPLAN analyses.

2.2 Maternal sire project

1). Mate c. 1,750 maternal composite ewes p.a. across four sites to c.35 composite maternal sires to produce 600-700 daughters.
2). Mate the daughters twice to composite maternal sires and recorded production traits (scanned conception rate, NLW, WWt, PWt, WEC, slaughter weight, carcase weight).
3). Completed economic modelling to improve estimation of economic parameters that underpin selection indexes. This will include investigation of the potential need to vary index weightings to achieve the best outcome under different production environments.
4). Utilise slaughter progeny for further R&D as opportunities arise, for example, carcase yield data should DEXA estimation be available, either commercially or in future R&D.

All appropriate data generated will be included in the RF/Sheep Genetics databases, as appropriate, to support current R&D and routine

2.3 Additional details

1.3.1 Data

All data collected will be added to the Resource Flock database for ongoing R&D and, as applicable, included in routine LAMBPLAN analyses to improve the estimation of breeding values.

1.3.2 Terminal sire project – Carcase trait recording

Sires used in the terminal sire project will be DNA tested using the 700K chip; slaughter progeny will be tested using the 50K chips. The cost of testing will be covered by MLA Resource Flock with all genotypes added to the Resource Flock database for industry benefit.

2. Methodology

3.1 Milestone 1 - Maternal Resource Flock: Completion of base ewes A.I. & DNA sampling of the ewes.

3.1.1 Hamilton Mating Program

Semen was collected from 8 sires and 400 ewes were artificially inseminated at Hamilton. Conception was average generating 154 ewe lambs for the project. These ewe lambs were DNA tested, weighed, and condition scored. The ewes mated at 93% in lamb, and the 7% dry ewes were culled out of the project. Lambing commenced in August 2016.

3.1.2 Wallendbeen Mating Program

Semen was collected from 18 sires, and 800 ewes were artificially inseminated at Wallendbeen. Conception was reasonable generating 374 ewe lambs. The ewes have been condition scored, weighed and DNA tested. The ewes mated at 84% in lamb. The 16% dry ewes were culled out of the project. Lambing commenced in August 2016.

3.1.3 Guyra Mating Program

Semen was collected from five sires and 250 ewes were artificially inseminated at Guyra. Conception was extremely poor. The decision made was to cease the Guyra program. Only 70 ewes were achieved making it an insufficient sample size to achieve adequate data quality. Most of the ewes were from three sires, including one link sire.

3.1.4 Young Mating Program

Semen was collected from 9 sires and 350 ewes were artificially inseminated. Lambing results were extremely good. DNA testing occurred post weaning in December 2016.

3.2 Milestone 2 – Terminal Resource Flock: Year 1 terminal sire slaughter progeny shortloin sample collection and EQ quality testing

A total of 115 Slaughter progeny, were generated using artificial insemination over composite ewe lambs at Young NSW. These lambs were run as one contemporary group from birth, and slaughtered by Thomas Foods International, Tamworth in February 2016. UNE staff were present at slaughter, and both shortloins were removed. One shortloin was tested for pH, marbling and Shear Force, the other eaten by a consumer panel.

3.3 Milestone 3 - Maternal Resource Flock: Base ewes body weight and WEC collection, Year 1 lambs DNA collection and analysis

3.3.1 Hamilton Mating Program

- Ewe joining weight and condition score was taken on 10 March 2016.
- Ewes were pregnancy scanned on 15 June 2016
- Lambing commenced in August 2016 and lambs were marked on the 3rd October.
- Lambs were weaned on 15 November 2016.

- DNA samples were taken from the lambs at weaning.

3.3.2 Wallendbeen Mating Program

- Ewe joining weight and condition score was taken in March 2016.
- Ewes were pregnancy scanned on 30 June 2016.
- Lambing commenced in August 2016 and lambs were marked on the 13th October.
- DNA samples were taken from the lambs at marking and sent to the Sheep CRC in December for matching to dam.
- Lambs were weaned on 2 December 2016

3.3.3 Guyra Mating Program

The Guyra program was discontinued due to poor results achieved in the initial AI, failing to generate enough daughter progeny from sufficient sires.

3.3.4 Young Mating Program

Approximately 175 ewe lambs were generated from the initial ewe mating in 2016. These ewe lambs were DNA sampled in January 2017, and joined in March/April for their first lambing in spring.

3.4 Milestone 4 - Maternal Resource Flock: Base ewes body weight and lambs weaning weight collected, WEC collected

3.4.1 Hamilton Mating Program

- Lambs weaned on 15 November 2016
- 143 base ewes were re-joined on 11 January 2017
- Pregnancy scanning took place 31 March 2017

3.4.2 Wallendbeen Mating Program

- Lambs were weaned on 2 December 2016
- Base ewes were re-joined on 26 January 2017
- Pregnancy scanning occurred in mid-April

3.4.3 Guyra Mating Program

The Guyra program was discontinued due to poor results achieved in the initial AI, failing to generate enough daughter progeny from sufficient sires.

3.4.4 Young Mating Program

- 157 ewes were joined on 21 March 2017
- Pregnancy scanning occurred on 5 June 2017

3.5 Milestone 5 - Maternal Resource Flock: Year 2 lambs DNA Collection and analysis, Year 2 lambs Wwt collection

3.5.1 Hamilton Mating Program

- Lambs were weaned on 14 October 2017
- DNA samples were collected from the lambs at weaning

3.5.2 Wallendbeen Mating Program

- Lambs were weaned on 19 October 2017
- DNA samples were collected from the lambs at weaning

3.5.3 Guyra Mating Program

The Guyra program was discontinued due to poor results achieved in the initial AI, failing to generate enough daughter progeny from sufficient sires.

3.5.4 Young Mating Program

- 169 lambs were weaned on 15 November 2017.
- No DNA samples collected
- With recommendations from MLA, the Young program was discontinued due to poor data collection.

3.6 Milestone 6 & 7 – Terminal Resource Flock: Year 2 terminal sire slaughter progeny shortloin sample collection and EQ quality testing, including UNE sensory

3.6.1 Year 2 terminal sire slaughter progeny shortloin sample and EQ quality

A total of 134 slaughter progeny were generated using artificial insemination over composite ewes at Young NSW. These lambs were run as one contemporary group from birth, and slaughtered by Thomas Foods International Tamworth in October 2017. UNE staff and LAMBPRO staff were present at slaughter, and both shortloins were removed. One shortloin was tested for pH, marbling and Shear Force, the other eaten by a consumer panel.

3.6.2 Year 3 terminal sire slaughter progeny shortloin sample and EQ quality

A total 66 slaughter progeny were generated using artificial insemination over composite ewes at ***Young NSW***. These lambs were run as one contemporary group from birth and slaughtered by Thomas Foods International Tamworth in October 2018. UNE staff were present at slaughter, and both shortloins were removed. One shortloin was tested for pH, marbling and Shear Force, the other eaten by a consumer panel.

A total of 378 slaughter progeny were generated from natural matings over composite ewes at ***Holbrook NSW***. These lambs were run as two contemporary groups from birth and slaughtered by Thomas Foods International Tamworth in November & December 2018. UNE staff were present at slaughter, and both shortloins were removed, with pH, marbling and Shear Force data being collected. No consumer data was collected, as a consequence of the high correlation between IMF% and consumer scores from the previous data collected in years 1, 2 and 3a of the project.

3.7 Milestone 8 – Data analysis, maternal and terminal index development

3.7.1 Maternal Index Development

Mark Ferguson of Next Gen Agri was employed to develop a new LAMBPRO$ index. The objective of developing the new index, was to better encapsulate the profit driving traits across varying environmental regions of Australia. Given the LAMBPRO Maternal Resource Flock had an insufficient data size across varying environments, further data was needed to develop the index. This change in project objectives was discussed with MLA and was given approval.

The index was developed based on relative economic values generated using the Discovery model developed to compare genotypes while keeping the dry matter consumed by the production system to be the same.

The base flock structure used for modelling was a flock of 1000 mixed age ewes and the associated followers. The base scanning for mixed aged ewes was 170% and 160% for 2 tooth ewes. Lamb wastage was around 18% depending on the scenario. In all models the ewes were mated as ewe lambs.

Relative economic value estimation

The base model was altered individually for each trait. In all cases the model generated a Gross Margin difference between the flock in base model and the flock in the model adjusted for the trait change. This gross margin was divided by 1000 to reflect a gross margin per mixed age ewe in the flock. The relative economic values (REVs) were then combined into an index.

The modelling assumptions used for each trait are:

Trait	Model changes made
MWWT	Added 1kg to weaning weight to lambs of MA ewes, 0.9kg to weaning weight of lambs of 2 tooth ewes and 0.7kg weaning to lambs of ewe lambs
WWT	Added 10g/day on to lamb growth over the three months post weaning. This was done rather than 1kg of weaning weight to account for direct effects of growth and to ensure the value allocated to MWWT wasn't double counted in the model.
PFAT	Reduced the amount of supplementary feed by 2.5% through the Jan-April period
PEMD	Added 0.5% to dressing percentage in accordance with Gardner et al. also calculated that the increase in loin weight would increase carcass value by 1c per kg dressed weight and added that on
YCON	Added 1% on to the number of ewe lambs getting pregnant
LS	Added 1% on to the number of ewes scanning twin
ERA	Reduced lamb wastage by 1%
AWT	Built a new intake profile based on ewes being 1kg heavier across the year
YGFW	Added 1% of fleece weight to all shorn animals
IMF	Added 30c per kg to all prime lamb prices
YFD	Reduced all fleece fibre diameter by 1 micron

REV outputs

The relative economic values were combined into an index. These are as they were generated by the modelling process except in the case of the reproduction traits. These have all been multiplied

by 100 to account for the fact that the relevant breeding values are all decimals rather than percentages.

3.7.2 Terminal Index Development

Since completion of the terminal progeny test slaughter projects, LAMBPRO has spent a great deal of time assessing the value of using ASBVs to develop actual carcase values for sires. Weight, dressing percentage, lean meat yield, loin yields, and IMF have been used to determine the value of an animal in the LAMBPRO program.

The basis is the following:

Trait	**Model**
PWWT	A PWWT of 10kg animal has a liveweight of 55kg
DRESS %	A base dressing percentage of 47%
LMY	A base of 50% and then used the ASBV to get an estimated dressing percentage
Loin Yield	14% estimate of the lean meat was loin cuts. Then for every +1 = 1% loin value
Loin Carcase Value	For every +1 IMF was an additional $50 a kg starting from a base of $30. Note: Manually adjusted all values below $30, to $30, as low value loins will still be worth that in the marketplace.

Using the above basis, LAMBPRO calculated an overall carcase value derived from liveweight, dressing percentage, lean meat yield, loin weight, and carcase value, derived from IMF. The top sire was $430 for the outlier sire who is 1.96 for IMF and the bottom sires around $220. These value ranges are in line with what we are expecting at retail, such as the high-end butcher shop of Victor Churchill, which is LAMBPRO's target market.

LAMBPRO has approached AGBU (Andrew Swan & Daniel Brown) on numerous occasions in regard to developing the terminal index. Unfortunately, this index is still to be developed by AGBU.

4 Results

4.1 Milestone 1 – Maternal Resource Flock: Completion of base ewes A.I. & DNA sampling of the ewes.

The aim of the first milestone was to generate daughters for the LAMBPRO Maternal Resource Flock. The sires used represented were a genetically diverse group, including proven, unproven and New Zealand sires. Special emphasis was given to ensuring the traits were diverse, to get a full range of production characteristics within the sire group.

These daughters were generated and are now in reproduction phase. Numbers will be adequate in three of the four sites. Due to insufficient data, the Guyra resource flock was discontinued.

4.2 Milestone 2 – Terminal Resource Flock: Year 1 terminal sire slaughter progeny shortloin sample collection and EQ quality testing

Lambs were produced, run successfully as a contemporary, and slaughtered with carcase data and consumer sensory data collected as required (Figures 1 & 2). These results were compiled by MLA (Table 1) and sent to LAMBPRO. The information was added to the SGA database.

Figure 1. Consumer sensory testing of Year 1 lambs taking place at the University of New England.

Figure 2. Portions of Year 1 lambs being cooked for consumer sensory testing.

Table 1. Sire averages extrapolated from the 2016 kill data and consumer sensory testing

ID	Shear Force (SF)	IMF	Tenderness	Juiciness	Flavour	Overall Liking	CMQ4
1400312011110678	3.1	4.2	82.3	76.2	78.1	79.3	79.5
1400312012120577	3.3	3.9	68.1	63.4	68.5	68.2	67.5
1644222014140545	4.5	3.3	66.0	69.3	68.2	67.9	67.1
164422014140074	2.6	4.1	70.7	70.3	70.9	71.9	70.6
1644222014140345	3.1	3.6	65.9	66.1	68.0	69.0	67.3
1644222014140860	2.9	3.8	69.8	67.6	71.4	72.4	70.1

4.3 Milestone 3 - Maternal Resource Flock: Base ewes body weight and WEC collection, Year 1 lambs DNA collection and analysis

4.3.1 Hamilton Mating Program

- Ewe joining weight and condition score was taken on 10 March 2016. Average weight 51.85kg and condition score 3.07.
- Ewes were pregnancy scanned on 15 June 2016, and achieved 161.1% conception to ewes joined (Table 2).
- Lambing commenced in August 2016 and lambs were marked on the 3rd October. 149 lambs were marked.
- DNA samples were taken from the lambs at weaning and sent to the Sheep CRC in December for matching to dam. Lamb DNA results returned January 2017. Dam results returned were December 2016.

Table 2. Hamilton site sire analysis, year 1 lambs.

SIRE	1 YO Count	1YO Conception %
CM00052012122217	13	169.2%
CM00052014142399	19	147.4%
CM00052014142506	20	150.0%
CM00052014142564	13	138.5%
CM00052014142660	15	133.3%
CM00052014142722	20	175.0%
CM00052014143113	11	181.8%
SI44742007071699	20	190.0%
Grand Total	***131***	***161.1%***

4.3.2 Wallendbeen Mating Program

- Ewe joining weight and condition score was taken in March 2016. Average weight 48.5kg and condition score 3.2.
- Ewes were pregnancy scanned on 30 June 2016, and achieved 147.4% conception to ewes joined. (230 ewes) (Table 3).
- Lambing commenced in August 2016 and lambs were marked on the 13th October. 302 lambs were marked (85.1% lambs marked to ewes joined).
- DNA samples were taken from the lambs at marking and sent to the Sheep CRC in December for matching to dam. Dam results returned were December 2016.

Table 3. Wallendbeen site sire analysis, year 1 lambs

SIRE	1YO Count	1YO Conception %
2300022006060073	23	152.2%
2306362006060959	19	147.4%
CM00052012122217	13	107.7%
CM00052014142311	22	136.4%
CM00052014142610	20	145.0%
CM00052014143578	21	147.6%
CM00052014143817	31	154.8%
SI09162007070094	22	150.0%
SI09162011110031	23	156.5%
SI44742007070807	15	146.7%
SI44742007071699	21	157.1%
Grand Total	***230***	***147.4%***

4.3.3 Young Mating Program

Approximately 175 ewe lambs were generated from the initial ewe mating in 2016. These ewe lambs were DNA sampled in January 2017, and were joined in March/April for their first lambing in spring.

4.4 Milestone 4 - Maternal Resource Flock: Base ewes body weight and lambs weaning weight collected, WEC collected

4.4.1 Hamilton Mating Program

- 145 lambs were weaned on 15 November 2016, with an average weaning weight of 25.9kg (93.5% lambs weaned to ewes joined).
- 118 base ewes were re-joined on 11 January 2017, with an average joining weight of 77.6kg.
- Pregnancy scanning occurred on the 31 March, with a resulting conception of 158.5% including 7 dry ewes (Table 4).

Table 4. Hamilton site sire analysis, year 1 lambs weaning weights & year 2 conception

SIRE	1 YO Count	1YO Weaning %	1YO Avg lamb wwt	1YO kg LW/ewe	2 YO Count	2YO Conception %
CM00052012122217	13	146.2%	26.0	38.0	13	161.5%
CM00052014142399	19	89.5%	26.5	23.7	16	143.8%
CM00052014142506	20	100.0%	24.3	24.3	17	152.9%
CM00052014142564	13	76.9%	28.8	22.1	12	175.0%
CM00052014142660	15	66.7%	24.5	16.3	12	141.7%
CM00052014142722	20	100.0%	26.6	26.6	19	147.4%
CM00052014143113	11	118.2%	27.5	32.5	11	154.5%
SI44742007071699	20	95.0%	24.2	23.0	18	188.9%
Grand Total	***131***	***97.7%***	***25.9***	***25.3***	***118***	***158.5%***

4.4.2 Wallendbeen Mating Program

- 285 lambs were weaned on 2 December 2016, with an average weaning weight of 32.3kg (80.2% lambs weaned to ewes joined).
- 230 base ewes were re-joined on 26 January 2017, with an average joining weight of 69.2kg.
- Pregnancy scanning occurred in mid-April, with a resulting conception of 152.4%, including 7 dry ewes (Table 5).

Table 5. Wallendbeen site sire analysis, year 1 lambs weaning weights & year 2 conception

SIRE	1YO Count	1YO Weaning %	1YO Avg lamb wwt	1YO kg LW/ewe	2YO Count	2YO Conception %
2300022006060073	23	69.6%	33.0	23.0	21	161.9%
2306362006060959	19	47.4%	29.9	14.1	17	147.1%
CM00052012122217	13	46.2%	31.7	14.6	8	137.5%
CM00052014142311	22	68.2%	31.8	21.7	18	172.2%
CM00052014142610	20	60.0%	34.8	20.9	17	164.7%
CM00052014143578	21	57.1%	32.7	18.7	15	140.0%
CM00052014143817	31	67.7%	33.4	22.6	28	142.9%
SI09162007070094	22	77.3%	32.3	25.0	19	110.5%
SI09162011110031	23	73.9%	35.4	26.2	21	166.7%
SI44742007070807	15	66.7%	34.1	22.7	11	163.6%
SI44742007071699	21	81.0%	27.4	22.2	16	168.8%
Grand Total	***230***	***66.1%***	***32.4***	***21.4***	***191***	***152.4%***

4.4.3 Young Mating Program

- 157 ewes were joined on 21 March 2017, with an average joining weight of 61.9kg.
- Pregnancy scanning occurred om 5 June, with a resulting conception of 144.0%, including 22 dry ewes.

4.5 Milestone 4 - Maternal Resource Flock: Year 2 lambs DNA Collection and analysis, Year 2 lambs Wwt collection

4.5.1 Hamilton Mating Program

- 179 lambs were weaned on 14 October 2017, with an average weaning weight of 35.7kg (99.2% lambs weaned to ewes joined) (Table 6).
- DNA samples were collected from the lambs at weaning and sent to the Sheep CRC for analysis.

Table 6. Hamilton site sire analysis, year 2 lambs weaning weights.

SIRE	2 YO Count	2YO Weaning %	2YO Avg lamb wwt	2YO kg LW/ewe
CM00052012122217	13	92.3%	37.2	34.3
CM00052014142399	16	81.3%	37.8	30.7
CM00052014142506	17	123.5%	35.7	44.1
CM00052014142564	12	116.7%	37.4	43.6
CM00052014142660	12	91.7%	36.6	33.5
CM00052014142722	19	84.2%	34.8	29.3
CM00052014143113	11	109.1%	33.0	36.0
SI44742007071699	18	100.0%	34.3	34.3
Grand Total	***118***	***99.2%***	***35.7***	***35.4***

4.5.2 Wallendbeen Mating Program

- 376 lambs were weaned on 19 October 2017, with an average weaning weight of 30.6kg (124.1% lambs weaned to ewes joined) (Table 7).
- DNA samples were collected from the lambs at weaning and sent to the Sheep CRC for analysis.

Table 7. Site sire analysis, year 2 lambs weaning weights.

SIRE	2YO Count	2YO Weaning %	2YO Avg lamb wwt	2YO kg LW/ewe
2300022006060073	21	142.9%	31.2	44.5
2306362006060959	17	117.6%	34.3	40.4
CM00052012122217	8	112.5%	29.0	32.6
CM00052014142311	18	105.6%	29.0	30.6
CM00052014142610	17	135.3%	33.1	44.8
CM00052014143578	15	146.7%	31.8	46.7
CM00052014143817	28	121.4%	31.1	37.7
SI09162007070094	19	78.9%	31.2	24.6
SI09162011110031	21	133.3%	33.5	44.7
SI44742007070807	11	154.5%	20.5	31.7
SI44742007071699	16	125.0%	27.0	33.8
Grand Total	***191***	***124.1%***	***30.6***	***37.9***

4.5.3 Young Mating Program

- 169 lambs were weaned on 15 November 2017, with an average weaning weight of 31.6kg (107.6% lambs weaned to ewes joined).
- DNA samples were not collected at weaning

4.6 Milestone 6 & 7 – Terminal Resource Flock: Year 2 terminal sire slaughter progeny shortloin sample collection and EQ quality testing, including UNE sensory

The year 2 (2017) and year 3 (2018) lambs were produced, run successfully in contemporary groups, and slaughtered with carcase data and consumer sensory data collected as required (Figures 3, 4, 5, 6 & 8). The year 2 lambs highlighted a significant range in overall consumer liking (Table 8), as well as significant breed differences in regard to average IMF%, with Hampshire Down lambs averaging higher than both Dorset and Tradie lambs (Figure 7).

Figures 3. Year 3 slaughter lambs tissue sample collection at lamb marking

Figure 4. Year 2 progeny test lamb carcases slaughtered at Thomas Foods International (TFI) Tamworth.

Figure 5. Collection of pH data of year 2 slaughter lambs at TFI Tamworth

Figure 6. Boning out year 2 lamb shortloins to collect samples for chemical analysis as well as consumer sensory data at the University of New England.

Table 8. Sire averages extrapolated from the 2017 consumer sensory testing.

Sire	Tenderness	Juicy	Flavour	Overall Liking
1101852014141456	67.50	62.97	67.13	66.30
1644222016160135	65.42	60.72	64.78	65.73
1644222015150513	64.21	65.01	64.46	65.29
1644222016160264	61.56	61.98	67.00	64.68
1644222016160299	60.90	60.65	65.00	63.35
1101852014140635	67.75	64.20	60.82	62.97
1644222016161193	57.04	57.50	60.73	59.35
1644222016160329	54.54	53.94	61.07	59.10
1101852014141432	57.11	54.98	58.60	58.20
1644222014141216	53.57	56.96	61.19	58.00
1644222016160271	56.92	54.15	57.15	56.68
1644222016161174	49.64	53.23	55.67	55.06
1644222015151250	47.16	48.94	54.40	51.55
1644222016160092	45.11	52.22	55.92	51.48
1400312015150645	45.45	47.20	50.70	50.35

Figure 7. Comparison of average IMF (%) between the three breeds tested in the 2017

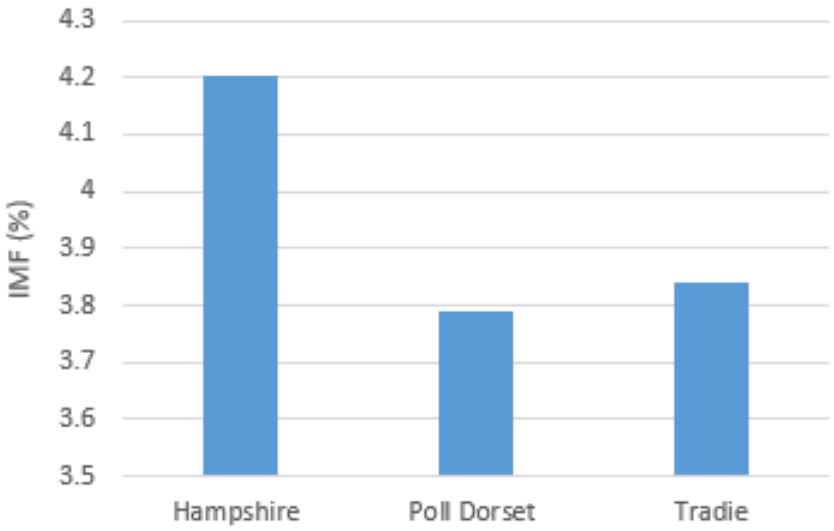


Figure 8. Loin eye sample from a lamb sired by a Hampshire Down sire. It was this level of IMF that lead to further research into the Hampshire Down breed.

The third year of lambs (2018) were produced, and slaughtered, with carcase data collected (Tables 9 & 10). The data captured shows significant variation in IMF% between sires and across varying breeds, highlighting the benefit of the project. Of the 42 sires tested, there was a total variation of 3.6% in IMF% across all sires tested.

Table 9. Sire averages of year 3 cohort 1 terminal lambs, produced in Young NSW

ID	IMF %	Avg of SF (kg)
1100392014141419	4.454481483	3.378375154
1101172016166067	4.088093678	5.272323104
1101482016160549	3.88030537	3.437652516
1101832016166051	4.304087567	3.55502452
1101852014141456	4.717020353	4.023212323
1101852016166212	4.97948904	2.894920416
1101852016166214	4.334884524	2.599205051
1101942016160031	5.336876869	3.840171273
1102022013130322	4.645624638	3.48492447
1102022013130443	4.915325165	3.278141631
1102022014140555	6.385009885	3.081072549
1102022014140571	5.38101387	2.668223467
1102022016160790	3.847844005	4.114779364
1619722013130156	4.419332504	3.413521338
Grand Total	4.34408574	3.712322068

Table 10. Sire averages of year 3 cohort 2 terminal lambs, produced in Holbrook NSW

Sire	IMF (%)	SF (N)
1644222017171259	5.98	31.44
1400312016160838	5.42	30.84
1102022017171006	5.24	31.62
1102022017170950	5.00	42.02
1102292017171834	4.70	34.97
1102022014140490	4.60	36.68
1101852015155313	4.51	39.52
1101852016166202	4.51	34.85
1102292017171168	4.42	34.91
1102122016161601	4.30	42.91
1102292017171165	4.25	33.08
1644222017170110	4.23	31.30
1102022017170817	4.19	35.88
110194201616027H	4.16	40.05
1102022017170802	4.15	45.33
1101942015150011	4.02	22.23
1102292017171076	4.01	29.51
1102292017171664	3.91	36.39
1101782015151501	3.88	33.53
1102022013130311	3.86	36.79
1102292017171170	3.79	38.66
1101942016160027	3.79	36.27
1102022017170973	3.66	35.95
1102292017171633	3.65	27.99
1644222017170860	3.60	28.26
1102022017170832	3.52	42.47
1101852016166214	3.52	33.55
1100392014141419	3.46	31.83
Average	4.23	34.96

4.7 Milestone 8 – Data analysis, maternal and terminal index development

4.7.1 Maternal Index Development

Mark Ferguson of Next Gen Agri was employed to develop an economic model. Through economic modelling the LAMBPRO$ 5 index was developed (Figure 10). In comparison to the LAMBPRO$ 3 Index (Figure 9) (the current LAMBPRO$ Index used), the LAMBPRO$ 5 index has incorporated wool traits (yearling fibre diameter & yearling greasy fleece weight), and has utilised the new fertility traits launched by Sheep Genetics in 2019.

Figure 9. Displays the weightings applied for each trait in the current LAMBPRO$ Index.

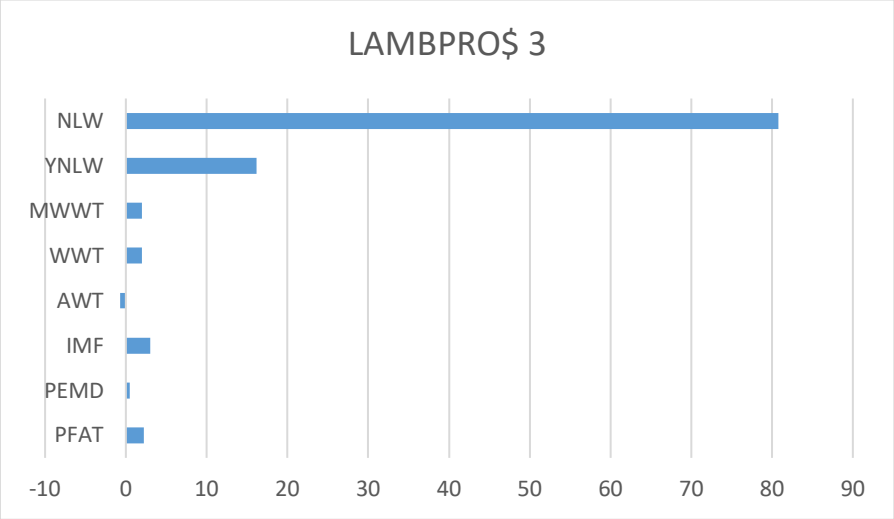
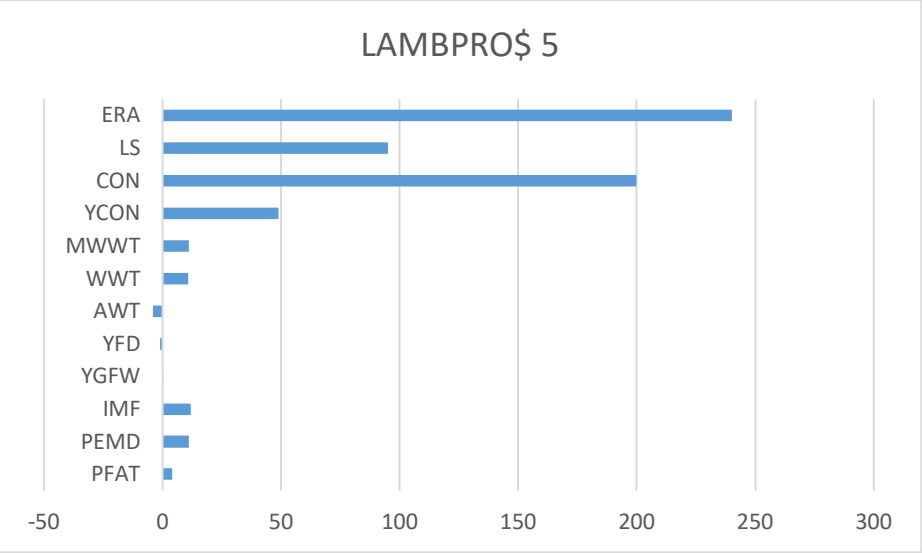


Figure 10. Outlines the additional traits added to the new LAMBPRO$ index and the weightings applied to each trait.



4.7.2 Terminal Index Development

Currently in development stage with AGBU.

5 Discussion

5.1 Milestone 1 – Maternal Resource Flock: Completion of base ewes A.I. & DNA sampling of the ewes.

The aim of the first milestone was to generate daughters for the LAMBPRO Maternal Resource Flock. The sires used represented were a genetically diverse group, including proven, unproven and New Zealand sires. Special emphasis was given to ensuring the traits were diverse, to get a full range of production characteristics within the sire group.

The daughters were generated and were then utilised in the reproduction phase. Numbers were adequate in three of the four sites. The question regarding whether Guyra resource flock is continued was raised.

5.2 Milestone 2 – Terminal Resource Flock: Year 1 terminal sire slaughter progeny shortloin sample collection and EQ quality testing

Lambs were produced, run successfully as a contemporary, and slaughtered with carcase data collected as required. These results were compiled by MLA and sent to LAMBPRO. The information was added to the SGA database. The initial information highlights the opportunity to select sires that significantly enhance eating quality.

5.3 Milestone 3 – Maternal Resource Flock: Base ewes body weight and WEC collection, Year 1 lambs DNA collection and analysis

The aim of the third milestone was to collect body weight and worm egg count data for the base ewes, and to collect and analyse DNA samples from their progeny. Joining body weight and condition score was collected from the base ewes, however due to difficult seasonal conditions the worm egg counts were not collected.

5.4 Milestone 4 – Maternal Resource Flock: Base ewes body weight and lamb weaning weight collected, WEC collected

The aim of the fourth milestone was to collect body weight and worm egg count data for the base ewes, and to collect weaning weights from their progeny. Joining body weight was collected from the base ewes, however due to difficult seasonal conditions the worm egg counts were not collected. It was decided between MLA and LAMBPRO personnel, that WEC collections be disregarded from the project.

5.5 Milestone 4 - Maternal Resource Flock: Year 2 lambs DNA Collection and analysis, Year 2 lambs Wwt collection

The aim of the fifth milestone was to collect weaning weights and DNA samples from the 2017 drop progeny, and analysis of the DNA samples for dam parentage.

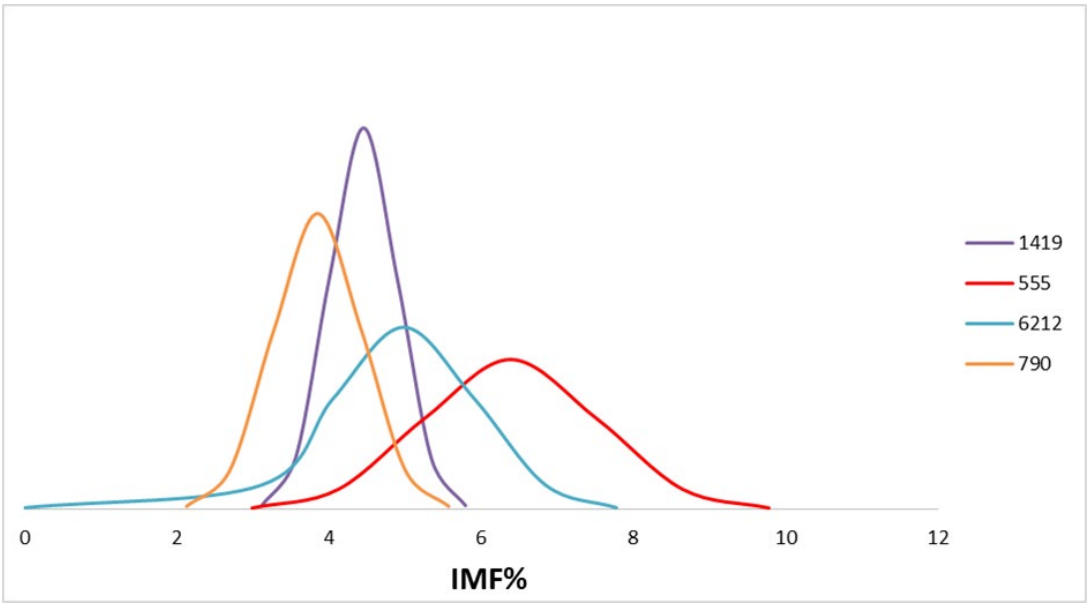
All weaning weight data has been collected, and DNA samples taken from two of the sites

5.6 Milestone 6 & 7 – Terminal Resource Flock: Year 2 terminal sire slaughter progeny shortloin sample collection and EQ testing, including UNE sensory

Years 2 and 3 lambs of the LAMBPRO Terminal Resource Flock were produced, run successfully as a contemporary, and slaughtered with carcase data collected as required. These results were compiled by MLA and sent to LAMBPRO. The information has been added to the SGA database.

The data captured from both cohorts highlights the opportunity to select sires that significantly enhance eating quality. The data also suggested the Hampshire breed on average, has a higher propensity marble (Figure 1). Interestingly, the data from the year 3 lambs, demonstrated that not all Hampshire Down has a high propensity to marble though, and that some are below the Australian national lamb industry IMF% average (Figure 11).

Figure 11. Snapshot distribution of IMF% of individual Hampshire Down sires tested throughout 2018



5.7 Milestone 8 – Data analysis, maternal and terminal index development

5.7.1 Maternal Index Development

The LAMBPRO$5 Index was created through economic modelling conducted by Next Gen Agri. In regard to fertility traits, compared to Litter Size, a greater deal of emphasis was placed on Conception and Ewe Rearing Ability (Figure 10). This was a consequence of the data captured previously from the Wallendbeen and Hamilton maternal progeny test sites in this project. Sires which produced the greatest litter size, didn't generally produce the greatest kilograms of lamb weaned per ewe; a profit driver of lamb production (Table 7).

In regards to the impact of the newly developed LAMBPRO$ index, the average improvement if we

mated the top 50% of ewes to the top 10% of rams based on each index is outlined in Table 11. Using the LAMBPRO$ 5 Index, it is projected that ewes which produce greater amounts of milk, heavier lamb weaning weights, as well as lambs that have greater amounts of muscle and IMF will be produced, whilst lowering ewe fibre diameter and increasing fleece weight. Using the LAMBPRO$ 5 index, profit driving traits are being pushed in a positive direction for lamb production profitability.

Table 11. Comparison of current LAMBPRO$ index and the new LAMBPRO$ 5 index.

	LAMBPRO$ 3	LAMBPRO$ 5
MWWT	0.34	0.67
WWT	0.62	0.78
PWT	1.01	0.98
AWT	0.88	0.66
PEMD	-0.05	0.16
PFAT	0.24	0.15
YGFW	1	1.17
YFD	0.05	-0.06
IMF	0.08	0.09
CS	0.02	0.02
YCON	0.03	0.02
CON	0	0
LS	0.03	0.01
ERA	0	0
NLW	0.04	0
YNLW	0.05	0.01
MCP+	6.17	6.09

5.7.2 Terminal Index Development

Once the Terminal EQ Index is developed, it will be used in the LAMBPRO terminal breeding programs, to aid in breeding specialised high EQ sires to produce premium high IMF (>7%) lamb (Figure 12), for target markets such as Victor Churchill butcher shop domestically, numerous export markets.

Figure 12. Hampshire down lamb displaying greater than 7% IMF.

6 Conclusions/recommendations

6.1 Milestone 1 - Maternal Resource Flock: Completion of base ewes A.I. & DNA sampling of the ewes.

The objective of milestone 1 was to develop a base flock of ewes to test over two lambing's on four sites. Apart from Guyra, who lacked numbers (70 ewes), the other three sites had excellent numbers, averaging 23 ewes per sire. This was enough to gain high accuracy information from two lambing's.

The recommendations were to discontinue the Guyra ewes, as 70 from 5 sires would lack critical mass, especially given two sires (including one link) will sire most of the ewes.

6.2 Milestone 2 – Terminal Resource Flock: Year 1 terminal sire slaughter progeny shortloin sample collection and EQ quality testing

Data captured from the first cohort of lambs, demonstrated that there was significant variation in consumer overall liking scores, highlighting the benefit of the project. The top sire was 9% higher than the 2nd ranked sire for Overall Consumer liking score. This is considered extreme and highlights the opportunity for improvement in this key trait.

The recommendations were to expand the trial to 20 sires in 2017, to target a greater section of the LAMBPRO and industry gene pool. This would help build accuracy and a greater understanding of how we, as an industry, can produce genes that enable production of high-quality lamb.

6.3 Milestone 3 – Maternal Resource Flock: Base ewes body weight and lambs weaning weight collected, WEC collected

Due to difficult seasonal conditions, it was decided to delay the worm egg counts of the base ewes, and it is recommended that this occurs in autumn 2017.

6.4 Milestone 4 – Maternal Resource Flock: Base ewes body weight and lamb weaning weight collected, WEC collected

Due to difficult seasonal conditions, it was decided to delay the worm egg counts of the base ewes, and it is recommended that this occurs at lamb marking in 2017.

It was previously recommended in the Milestone One report that the Guyra program be discontinued due to insufficient numbers of daughter progeny being generated. Following this recommendation, the Guyra program has been discontinued.

6.5 Milestone 5 - Maternal Resource Flock: Year 2 lambs DNA Collection and analysis, Year 2 lambs Wwt collection

Ideally DNA samples should be taken on the day of weaning, to minimise the risk of missing animals. This was achieved at two of the sites but was not practical at the third site.

It was recommended that DNA samples of the remaining lambs were taken as soon as possible before the lambs were boxed up with other mobs on the property. Unfortunately, due to poor data collection methods, this collection did not happen. In discussions with MLA, it was recommended that the young site data be discontinued from the project.

6.6 Milestone 6 & 7 – Terminal Resource Flock: Year 2 terminal sire slaughter progeny shortloin sample collection and EQ quality testing, including UNE sensory

The second year (2017) of lambs has been completed. The data captured shows significant variation in consumer overall liking scores, highlighting the benefit of the project. There was a variance of 16 points for Overall Consumer liking score between sires used in the trial. Additionally, out of the four breeds tested the Hampshire Down consistently ranked higher by consumers.

The recommendations from 2017 were to expand the trial to test double the sires in 2018, targeting a greater section of the LAMBPRO and industry gene pool; building accuracy and a greater understanding of how as an industry we can produce genes that enable the production of high-quality lamb.

The last three years have enabled LAMBPRO to identify sire lines which have the capacity to produce highly marbled lamb, which consumers are demanding. This is only the beginning of producing a high-quality lamb product. Unlike the beef industry, there is still little evidence on how lambs should be finished to ensure a consistent high eating quality product is produced year-round. Likewise, the

desired carcase weight for processors and butchers, and portion sizes for food services retailers is still very much unknown. Moving forward, recommendations would be to continue to collect meat quality data on sire lines, whilst testing varying finishing regimes.

6.7 Milestone 8 – Data analysis, maternal and terminal index development

In conclusion, the newly developed LAMBPRO$ 5 index better encapsulates the varying profit driving traits which impact lamb production. This is achieved by incorporating new fertility traits, increasing the selection pressure on milk, muscle and lamb weaning weights, whilst optimising adult weight and wool production traits. On completion of this project, LAMBPRO will be offering the newly developed index to their client base of over 300 lamb producing businesses in 2020.

7 Key messages

7.1 LAMBPRO Maternal Resource Flock

There has been a number of key messages arise from this project since inception in 2015. First and foremost, the use of commercial enterprises to run maternal progeny testing is a difficult process. The attention to detail required to get not only the A.I.program right, but data collection as well, is often too difficult for large scale commercial producers.

Looking at the data, the highest ram for NLW produced the most lambs 154%, and the lowest NLW ram produced the least lamb 78% (Table 7). However, an important difference to note, was there was a 70% difference in weaning percent; highlighting the impact of using known genetics. The other major impact was the relationship between turn off weight and number of lambs weaned. The highest ranked ram 070807, had one of the lowest two-year-old weaning weight per ewe joined. The key message here is fertility is extremely important in self-replacing maternal models, but milk and early growth is just as vitally important to ensure lamb survival and optimal weaning weights.

Since completion of the project, we have analysed our internal LAMBPRO data, and have made significant change to our own sire selections, with more emphasis being placed on milk and growth. The development of the new LAMBPRO 5 index has reinforced this through economic modelling by Next Gen Agri, which favours sheep that can turn off lambs early, not simply have large litter sizes, with little ability to turn them off.

The benefit of these findings and key messages will filter through to the projected 950,000 lambs to be bred by LAMBPRO genetics in 2020.

7.2 LAMBPRO Terminal Resource Flock

The LAMBPRO Terminal Resource Flock project has and will have a profound impact on lamb in Australia. The project began looking at Poll Dorset, and Southdown sheep, and over time included the Hampshire Down. This inclusion saw the discovery of the leading marbling genetics in Australia, from a breed that had little to no performance data or had little inclusion in previous information nucleus projects with the Sheep CRC.

Since the first inclusion of Hampshire Down genetics, a significant number of rams were included from the Hampshire Down breed and as a breed they have been unparalleled. This finding has been the catalyst for the commencement of a lamb brand based on the Hampshire Down genetics.

Lamb has been trialled by leading Middle East, Chinese, and domestic markets with significant interest. In 2021 the first commercial shipments of lamb will commence to these markets. The future for a premium high IMF (>7%) is real, and all on the back of progeny testing as part of this project.