MEAT & LIVESTOCK AUSTRALIA

final report

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Integrating dual-purpose crops and eID into mixed farming systems

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Executive summary

The aim of this project was to demonstrate how the integration of dual-purpose crops and eID technology into mixed farming businesses can improve farm profitability through improved livestock feed base and improved genetic selection. The objectives were achieved through multiple dual-purpose cropping demonstration sites and increasing capacity for producers to collect relevant data with eID tags, which leads to improved genetic selection for desired traits. Both core and observer producer's adoption rates of eID technology increased by 37% by the end of this three-year project. Crop grazing adoption also increased by 19%.

Ultimately the goal for managing dual-purpose crops is to maximize the profit from the combined income from the grazed forage and the grain or hay. The uptake of this practice in our region has been slow. It was estimated that current uptake rate of less than 5% of our members at the beginning of the project. Solutions presently undertaken are; i) buy in feed sources, which impacts the cost of production, labour, and ability to secure high-quality feed sources; or ii) reducing the flock and/or herd breeding stock, which is a missed opportunity for profit. If the addition of dual-purpose crops into the system was shown to be viable both financially and in providing a high-quality feed base, then members are more likely to increase their stocking rates, which will improve enterprise diversity and business profitability and resilience.

The key findings of the dual-purpose crop demonstration in this project were that despite some yield loss, which was not always due to grazing, the grain yield penalties when harvested were generally minimal.

Other factors need to be considered when looking at the results regarding the success of crop grazing. The 2018 and 2019 season both had dry starts to the year. June was the break of season for most areas in both years. This meant there was minimal green feed available, with most growers still feeding sheep into July/August. Two of the host farmers were able to graze their green crops between May and July which reduced their supplementary feeding costs. Green feed is a valuable source and the cost benefits of crop grazing must be considered rather than just looking at losses through yield penalties. Growers utilising dual-purpose crops believe that having significant areas planted to long-season wheat is one way they can plan for and affordably mitigate drought-like conditions.

Although the crops were grazed by sheep in different life stages (i.e. pregnant ewes, wethers, and lambs) at seven of the eight demonstrations sites liveweights increased while grazing crops. The sheep gained between 0.015g – 0.376g/dayof weight after grazing the crops for between 2 weeks up to 10 weeks.

The demonstrations also highlighted how grazing crops improve enterprise diversity through grazing oats and summer forage crops. Growing alternate summer crops enables growers to grow cost-effective feed, which will be available to their livestock during the summer-autumn period when feed is normally scarce. All the growers involved in the demonstrations over this three-year project will continue to look at different ways summer forage crops and dual-purpose crops can work within their farming systems to boost their profitability and diversifying farming enterprises.

The use of data obtained from electronic eID systems requires demonstration and validation with SCF members. SCF producers are keen to learn more about how new technology, such as eID tags, can improve the way they can select higher performing ewes and progeny in commercial flocks. At the beginning of the project in 2016, very few of our members were currently using eID tags, but there was growing interest in how they can be utilised. Several of our members were keen to demonstrate to other farmers how an electronic tag identification system can be used in a

commercial ewe flock to help identify profitable maternal ewes for both rearing lambs for slaughter at five months and selecting replacement maternal merino ewes.

The eID and pedigreescan technology demonstrations resulted with mixed reviews. Growers found the pedigreescan quite labour intensive if not set up correctly and in an area, sheep walk through daily. Growers found they were reliant on the consultant to manage data because it was not user-friendly. They found they couldn't set up their own parameters, such as itemizing ewes into the top 20% of the mob in relation to certain traits. In summary, the pedigreescan did not fit into two of the three demonstration host's farming systems. They are, however, interested at looking into alternative mothering up technologies new to the market such as 'Smart Shepherd' Bluetooth tags which are claimed to be 96% accurate after 48 hours of use in the paddock.

The eID tags, however, were found to make data collection and processes accurate and efficient within the different enterprises. They found the eID technology to be timesaving, easy to use, and found the return on investment greater than the expense and therefore was able to justify the expense of the tags and wands. SCF producers will continue to use eID technology to collect data on liveweight gains, micron, fleece weights, and information that will provide extra data to stud ram buyers. Producers aim to continue using eID tags and data to identify and cull the worst performers whilst continuing to keep the best performers for breeding.

In 2018 Andrew used DNA technology to generate the pedigrees of his lambs. This involves taking a tissue sample from all the sires, ewes, and lambs. The DNA matches are then made, returning the parentage and poll horn status of each animal. The demonstration illustrated how the information from a DNA parentage test that can be gained by a breeder, relating to the progeny, dam, and sire from a breeding event, is likely to be recouped through making better decisions and hence improved genetic progress.

In the pre-project survey, 17.9% of respondents were using eID technology within their farming enterprises. In the post-project survey, the results show that 55% of respondents are now using eID technology on-farm, which is a 37% increase in adoption of eID technology. In 2018 the baseline survey found that 39% of respondents grazed their crops either every year or sometimes. The 2020 results showed that 58% of growers grazed their crops sometimes or yearly; this was an increase in adoption of 19%. From the survey data we have been able to identify how the project was successful in achieving its outcomes . Many of our growers will continue to look at ways they can incorporate eID technology and dual-purpose cropping into their farming enterprises to maintain farm viability and increase diversification. All demonstration hosts could see the benefits from either practice change that could deliver greater livestock profitability in the future. Ongoing research and information dissemination will be critical to the adoption of practices in the wider community.

In the case of eID tags, farmers need to have a clear understanding of how they will use the extra information obtained from installing the tags. If the data doesn't lead to be better breeding outcomes, or more efficient management of livestock it will not be adopted widely. Part of this demonstration project was to remove the fear associated with new technology adoption and to stimulate producers to think about how they could use eID tags within their businesses. Survey data collected by SCF indicates that more producers are using eID tags three years after the project began. Clearly, they have plans to utilise eID tags to enhance their livestock enterprises.

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1 Background

The aim of this project is to demonstrate how the integration of dual-purpose crops and eID technology into mixed farming businesses can improve farm profitability through an improved livestock feed base and genetic improvement/selection. This was achieved through dual-purpose cropping demonstration sites and increasing knowledge of how meaningful production data can be collected using eID tags. Once producers have greater quantity and quality data, they can make better genetic selections for their desired traits.

1.1 Dual Purpose Crops

SCF producers identified that their livestock enterprises are limited by the available feedbase. This is the case particularly in autumn (because of variable and often low near-surface PAW – Plant Available Water) and early winter. Due to seasonal variability in feed for sheep enterprises, producers have limited to <7 dseper Ha . Over 90% of the SCF producer membership runs significant livestock enterprises and could, based on MLA feedbase research, run well over ten dse per Ha

Research has shown that a wide range of options exists to optimise future available feedstock. Climate analysis for the SCF region shows that rainfall outside the conventional May to October growing season is increasing. The limiting factor is forecasting the distribution of rainfall. Producers are keen to demonstrate ways of managing this high variability in rainfall distribution to optimise the year in year out (YIYO) feedbase.

Parts of the SCF landscape are especially suited to perennials, and the balance is potentially highly productive with upgraded rotations of forage and fodder species integrated with high producing annual crops. Examples are pasture: crop systems (short phase perennials and crops), pasture mixes with cereals for high autumn dry-matter and dual-purpose crop options (including cereals and canola), which can increase the YIYO feedbase for sheep in autumn to early winter creating opportunities for producers to increase flock numbers, farm diversification and profitability. Dual-purpose crops also allow deferred grazing on annual pastures, giving them more time to establish and reach critical biomass before having stock graze them, which means more productive annual pastures.

The goal of dual-purpose crops is to maximize profit from the combined incomes of grazing and the harvested grain. Uptake of this practice in our region has been slow, with an estimated current uptake rate of less than 5% of SCF members. Current solutions to manage the autumn feed gap are; i) buy in feed sources, or ii) reducing the flock or herd breeding stock, which is a missed opportunity for profit. If the addition of dual-purpose crops into the system was shown to be viable financially and in providing a high-quality feed base, then members are more likely to increase their stocking rates, which will improve enterprise diversity and business profitability and resilience.

Current SCF research has demonstrated to growers that with an improved management system, dual-purpose crops can improve available feedbase and minimise grain yield losses. This project will enable SCF to demonstrate these initial results on a commercial scale with monitoring and evaluation giving producer members the appropriate knowledge and confidence to implement dual-purpose crops.

1.2 Slower Genetic Advances in commercial sheep enterprises

While ram breeders in the region have made substantial gains in genetic selection, SCF members have had slower breeding advances with ewes; having a limited ability to select for superior maternal genetics to optimize the use of improved ewe selection. The recent development in sheep technology such as the automatic electronic ID systems, PMM (pedigree matchmaker), UAV imagery, and WOW (walk over weighing) mean selecting for superior ewes is now commercially viable. The cost of using electronic systems for matching ewes to lambs is less than 25% of the manual cost in matching up ewes and lambs.

The need to select superior ewes regarding reproductive performance and productivity is just as crucial as the selection of rams. Presently, breeding stock is advanced primarily through the selection of rams using Australian Sheep Breeding Values (ASBV) indexes. With offspring receiving 50% maternal and paternal traits, it is just as imperative to use available resources in selecting superior ewes. By using knowledge obtained from the eID data, low performing lambs and their mothers can be identified and culled, increasing the rate of genetic gain and productivity of the flock by breeding only from elite animals.

The use of data obtained from electronic eID systems requires ongoing demonstration and validation with SCF producer members. SCF producers are keen to learn more about how new technology, such as eID tags, can improve the way they can select higher performing ewes and progeny in commercial flocks. At this stage, few of our members are currently using eID tags, but there is a growing interest in how they can be utilised. Some members are keen to demonstrate to other producers how an eID tag system can be used in a commercial merino ewe flock to help identify profitable maternal ewes for both rearing lambs for slaughter at five months and selecting replacement maternal merino ewes.

2 Project objectives

1. Demonstrate and quantify the benefits of using eID technology for selecting sheep in line with breeding objectives to 100% of SCF members.
2. Increase the rate of adoption of eID technology to enhance productive and reproductive traits of the sheep flock from 0% to > 10% of SCF members by 2019.
3. Demonstrate and quantify the benefits of integrating dual (summer and winter) purpose crops into mixed farming systems to enhance out of season feed base to 100% of SCF members.
4. Increase the rate of adoption of dual-purpose crops as part of a whole-farm management program from <5% to 20% of SCF members.
5. Measure sheep growth rates on Dual-purpose crops.
6. Demonstrate how to control weeds and pests in dual-purpose crops to 60% SCF members.
7. Conduct at least nine field walk activities to showcase the demonstration sites, results, and to encourage adoption.
8. Implement at least three demonstration/workshop events for SCF members to increase the confidence of integrating dual crops and eID technology (either or both) into farm businesses.
9. Conduct an annual showcase event highlighting livestock management system

3 Methodology

This project was implemented by a working group of 12 SCF members who collaboratively established demonstration sites in our region to support livestock intensification on mixed farming enterprises as follows:

Site	Location	Demonstration type	Demonstration Year
Jeff & Kate Stoney	Gnowellen	eID & Pedigreescan	2017
Andrew Slade	Kendenup	eID & Pedigreescan	2017, 2018 & 2019
Iain and Andrew Mackie	Mt Barker	eID and Pedigreescan	2019
Ashton Hood	South Stirling	Dual Purpose Crops	2017
Derek & Reece Curwen	South Stirling	Dual Purpose Crops	2017, 2018, & 2019
Jarrad Beech	West Kendenup	Dual Purpose Crops	2018 & 2019
Jeremy Walker	South Stirling	Dual Purpose Crops	2019

A baseline survey was taken from SCF members to assess current practices at the commencement of the project. Farmers who attend events (demonstration sites) were asked to fill out a before, after, and follow up survey to measure their level of awareness, understanding, and uptake (adoption) of new practices to the demonstration sites and other activities of the working group over the 3-year project period. The data includes both actual changes and anticipated changes to practices and learnings about barriers to uptake.

Two *Farmer to Farmer* subgroups (Western F2F Group and Eastern Stirlings F2F Group) in the Stirlings to Coast Farmer membership have both determined that optimizing the feedbase is their highest priority R&D issue for and hosted the demonstration sites to examine the issue.

The outcomes of the demonstration sites were measured through:

- data recorded at the demonstration sites and compared to 'current practices' as a control
- level of farmer participation at the demonstration site events and training workshops
- an economic analysis of activities, i.e., sheep weight/crop production before/after.

Farmers were invited to look at the effects on crop performance before/after grazing periods during the growing season.

3.1 Dual Purpose Crops demonstration

3.1.1 Summer Canola:

1. Late Spring/Early Summer sown (driven by soil moisture)
2. Monitor germination and growth for nutrient requirements, weeds, diseases, and pests.
3. Producers consult with agronomists as issues arise, which will all be documented
4. Pasture cages placed in the field on demonstration site and producer's normal feed base paddocks to compare and analyse the difference in feed base.
5. Weigh and body score sheep on entry of the grazing paddock

6. Graze late January, March, and June (rainfall dependent and when the entire plant cannot be pulled out by hand). The third grazing will be dependent on season and climate to maximise the return of crop for grain production.
7. Field days, videos and media events designed around significant events
8. Heavy, fast graze to low green leaf stage for disease and pest management (Canola may be overgrazed to help with insect threats such as diamond back moth and green peach aphids.
9. Weigh sheep and check body condition score on exit
10. Monitor crop and address issues until harvest of the crop. Tonnes per hectare of grain yield documented including quality of grain on both demonstration canola and neighbouring control paddocks of normal feed base management.
11. Monitor performance on crop/stubble residue vs standard cropping stubble/residue. It would include weeds and animal performance (may have increased crop residue or different feed value and potentially reduced summer weeds due to increased use of PAW).
12. Analysis performed on feed base produced, impact on sheep productivity, environmental effects, costs incurred, and final quality and yield of seed.

3.1.2 Winter Feed Cereals

1. March/April sown (driven by moisture – sowing window opportunities)
2. Monitor germination and growth for nutrient requirements, weeds, disease, and pests.
3. Producers consult with agronomists as issues arise, which will all be documented
4. Pasture cages placed in the field on demonstration site and producer normal feed base control paddocks to compare and analyse the difference in feed base.
5. Weigh the sheep entering crop for individual sheep weight recoding, also general over flock body condition scoring.
6. Field days and media events designed around significant events
7. Graze when at the four-leaf stage to Zadok 31, very light and even graze as per conclusion from previous trials in this area performed by (Barrett Lennard. P, 2014 SCF Crop Updates).
8. Weigh the sheep and record body condition score on exit
9. Monitor crop and address weed, disease, and insect issues (recording differences with control crops) until the harvest of the crop. Grain yield recorded and compared to control.
10. Monitor performance on crop/stubble residue vs standard cropping stubble/residue. It would include weeds and animal performance. (may have increased crop residue or different feed value and potentially reduced summer weeds due to increased use of PAW.
11. Analysis performed on feed base produced, impact on sheep productivity Analysis performed on feed base produced, impact on sheep productivity, environmental effects, costs incurred, and final quality and yield of seed.

3.2 eID Technology methods

Electronic ID tags were used to collect data comparing micron, fleece weight, body weight, and reproductive performance for individual ewes. Recent developments in sheep technology such as the automatic electronic ID systems and *Pedigreescan* were used for selecting superior ewes. One training workshop and one demonstration event was undertaken at each site each year over the three-year duration to show a) ease of use for eID technology, and b) how to analyse data from eID tags to determine individual animal characteristic performance for flock selection. Three main activities, using eID tags, were demonstrated during this project:

A. 'Using Pedigreescan to match ewes and lambs so the producer can improve 100-day cross-bred lamb weights'

1. Electronically tag 500 2 ½-year-old ewes
2. The ewes will be joined to rams as and pregnancy scanned for multiples.
3. Five hundred lambs, or more (depending on %) will be tagged with eID tags at lamb marking time (minimum 4 weeks old).
4. After lamb marking, the Pedigreescan unit will be set up strategically in a place that maximises ewe-lamb traffic and therefore number of recordings.
5. Pedigreescan will be run for as long as possible to maximise matchings and accuracy between the lambs and ewes.
6. Once data collection is finished, producer will download the data via a Bluetooth connection and send to Livestock consultant to analyse.
7. Lambs will be weighed by the producer at 100 days of age.
8. Assuming Pedigreescan provide accurate pedigree match, the producers are now able to cull the ewes with the lowest lamb weights when they are 100 days old. This is assuming the low lamb liveweight is not due to the ewe having twins or triplets.
9. Pedigreescan is also able to identify ewes with multiple lambs.
10. How the producers use this data will be different for each business. E.g. In this example the producer may want to compare the ewe performance over two years to see if results are consistent.

B 'Using eID tags to improve the efficiency of collecting wool samples from stud ram flock at shearing time'.

1. Rams already have eID tags in their ears
2. Obtain a stick eID reader (Allflex RS420), label maker, plastic bags and wool fleece scales
3. Collection of a wool sample, precise labelling, weighing of the ram fleece needs to occur in conjunction with the normal wool classing and shearing processes.
4. Extra staff are employed to complete the wool sample collecting and fleece weighing.
5. Aim is to minimise disruption to the shearers and rams, to reduce stress on both.
6. Using the stick reader to record the ram's individual eID tag will make the wool sampling and weighing process much easier with less errors and reduced stress on shed staff.
7. Step 1- Use Stick reader to record Rams eID tag as soon as shearer drags ram onto board.
8. Step 2- Label maker automatically prints sticker with Rams eID tag.
9. Step 3- Place sticker onto plastic bag. Leave bag near Ram.
10. Step 4- Collect wool sample from Ram's mid-side and place in the labelled plastic bag.
11. Step 5- Collect fleece from Ram and weigh it, and the sub-sample on the scales.
12. Step 6- Using another barcode reader, the fleece was easily identified accurately and recorded directly into a laptop.
13. The process of scanning the ram eID tag, printing the label, applying label to plastic bag and collecting the wool sample was easily done by one person for three shearers.
14. One person was dedicated to weighing the fleece and recording the data correctly into the laptop.

C 'Comparing pedigree matching using DNA sampling techniques and the Pedigreescan unit at Slade's in 2018'.

An opportunity presented itself within this project to add significant value to the original scope regarding the demonstration of eID tags. Andrew Slade had been using the Pedigreescan unit to match ewes and lambs in his stud ewe flock. During the project Andrew decided he would like to DNA match his ewes and lambs from 2018. Stirlings to Coast Farmers thought it would be a good exercise to compare to the two pedigree matching techniques.

SCF used project money to pay a livestock consultant for a short report comparing the pro's and cons of each method for collecting pedigrees and discussing the accuracy, of each method, in comparison to the cost.

1. Andrew Slade's stud ewe flock and lambs were matched using the Pedigreescan unit in a similar way as described above in section 'A'.
2. DNA samples were collected from the ewes and lambs using the Allflex tissue sampling units (TSU's). TSU's require a special set of pliers to take a small sample of ear tissue and seal it in a vial.
3. TSU's have a barcode that is matched to the eID tag of each individual sheep.
4. Send samples to *Neogen* for analysis
5. In Andrews case there were 14 sires, 406 dams and 471 lambs submitted
6. Cost in year one for the DNA sampling was $51.75, whilst every subsequent year will be approximately $27.75 per progeny.
7. Matching via the Pedigreescan system costs only $1.40 per progeny but is only 85% as accurate as DNA matching.

4 Results

4.1 Producer Surveys

A pre-project survey was sent out to Stirlings to Coast members in 2018. The survey was designed by SCF and approved by MLA to gauge member's current use of eID and dual-purpose cropping on-farm as a baseline for this project. Twenty-nine members were surveyed and re-surveyed throughout this project. In the pre-project survey, 17.9% of respondents were using eID technology within their farming enterprises. In the post-project survey, the results show that 55% of respondents are now using eID technology on-farm, which is a 37% increase in adoption of eID technology fig 1.

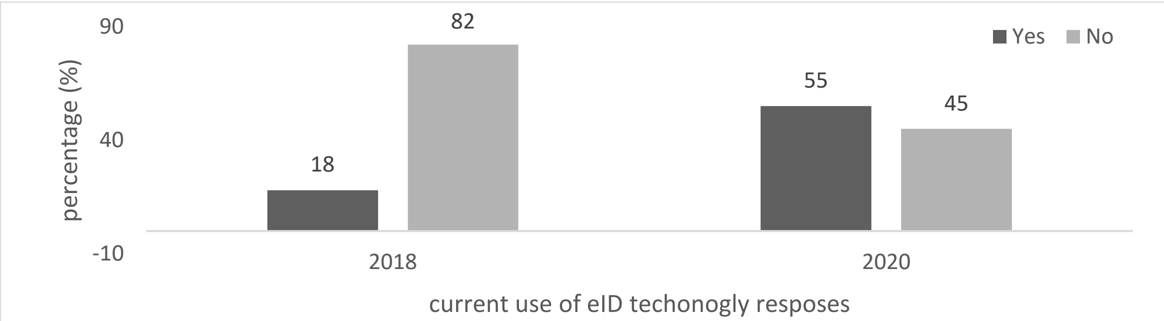

Figure 1 shows the percentage of respondents who are currently using eID technology in their sheep enterprises in a pre- and post-survey in 2018 and 2020

The awareness of eID technology remained the same, with the average number being 53 on a scale of 1 – 100 on how they would rate their knowledge/awareness about the use and application of eID in sheep. The main reason for not using eID tags the 2018 survey; 30% stated eID seems expensive, while another 30% were interested in using eID but was not sure how to get started. In the 2020 post-project survey, 44% were interested in using eID but were not sure of their value to their enterprise or how to get started. 22% stated they did not believe eID tags would be useful in their farming enterprise, while 11% stated it seems expensive.

Those who were using eID technology in 2018 saw potential benefits in using eID tags was stated by 50% of the respondent, and 16% were actively measuring one or more productive traits. 27% of respondents stated they are actively using eID technology to actively measure one or more productive traits in the 2020 post-project survey.

In 2018 the baseline survey found that 39% of respondents grazed their crops either every year or sometimes. The 2020 results showed that 58% of growers grazed their crops sometimes or yearly; this was an increase in adoption of 19% fig 2.

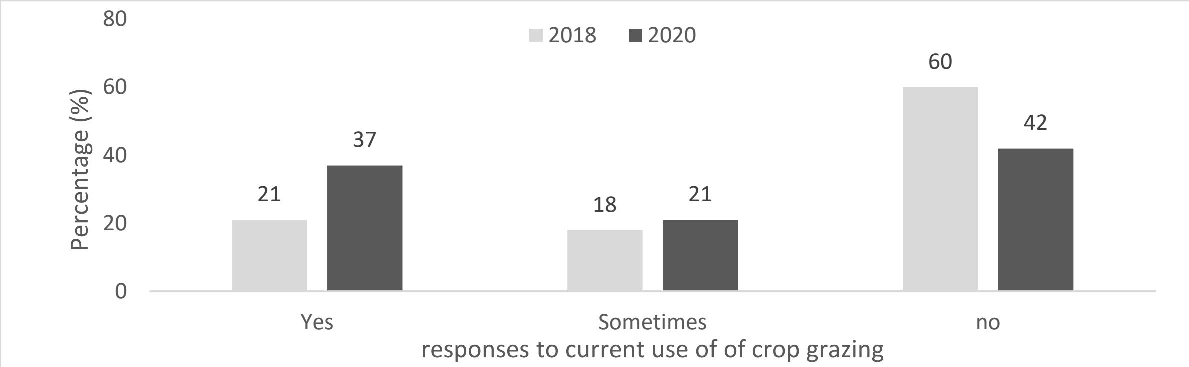

Figure 2 shows the percentage of respondents who are currently grazing their cropping paddocks in pre- and post-project surveys collected in 2018 and 2020

Respondents showed out of a scale of 1 – 100, the rating of knowledge/awareness of the use and application of grazing crops was 62. However, in 2020 the average rating was 57.

In the pre-project survey, 28% of respondents stated that they had tried crop grazing once or twice but did not plan to adopt it into their farming system. 25% were interested in the concept, however, but had yet to try it. The post-project survey showed 20% had tried crop grazing once or twice but did not plan to adopt it into their farming system. 30% were interested but were yet to try, and 30% graze their crops semi-regularly compared to 17% in 2018.

The main reason stated for not employing the grain and graze concept in both 2018 and 2020 was the concern around the extra level of management required to graze crops without a yield penalty.

4.2 *Pedigreescan* eID sites – Jeff & Kate Stoney

4.2.1 2017

The *Pedigreescan* was set up in July 2017 and recorded ewes and lamb matching for ten weeks. Ample time was allowed for matching ewes and lambs; the success rate was very poor, only achieving 9% accurate mothering. The mob of sheep had to be manually chased into the yarding area. They were then able to leave the yards via the *Pedigreescan* raceway. 100-day lamb weights were recorded, but the relationships to the key and bottom performing ewes could not be traced.

Sapien Technologies koolcollect (kc) has a pedigree matchmaker analysis application, and the output from this agrees with the output from Stockbook (SB). The analysis shows how the combination of the number of matches and the match% (SB)/proportion (kc)combine to give a Reliability (SB) /Score (kc). High-reliability results have a good number of matches and a high match% or proportion score. As either of these decreases, so does the reliability score. Scores of Class 1 and 2 give accurate results; however, with careful visual analysis, some Class 3 sheep with either a high match% (proportion score) can be used, providing there are multiple reads. With a score 3 lamb with six matches at 75%, where the majority of matches were with one ewe, the data was found to be a reliable match. Similarly, 3 matches at 100% would be acceptable in this case, as obviously that lamb only matched with that ewe and on more occasions than could be random). Thirty-five lambs from the mob of 398 lambs met the criteria of Score 1, 2, or acceptable Score 3 Table 1.

Table 1: Displays the number of acceptable lamb matches (35) out of the total mob of 398 lambs at Jeff and Kate Stoney's.

Reliability	Number matched	Matches	Match percentage
Class 1	2	>10	100%
Class 2	7	>5	100%
Class 2	4	>5	>75%
Class 2	8	4	100%
Class 2	4	4	>75%
Class 3	10	3	100%
Total matched	35		

4.3 *Pedigreescan* eID sites – Andrew Slade

4.3.1 2017 results

On the 24th of August 2017, Andrew Slade, under the guidance of Jonathon England from *Aginnovate*, set up *Pedigreescan* for his first and second tier *Greeline* stud ewe flock. The scanning unit was on a creek line in a small paddock where the sheep needed to pass through regularly. In just over two weeks, the unit recorded over 20,000 passes from the 300 ewes and 440 lambs.

Andrew started with one group of 220 ewes and 266 lambs on August 30, and added another group of 53 ewes and 72 lambs on September 6, and a final group of 54 ewes and 61 lambs on September 9, just two days prior to the completion of the use of the pedigreescan.

Two hundred forty lambs achieved match scores of classes one and two in Table 2. This is a great result with all but 18 of the 266 lambs in the first mob matched. There were also 169 lambs with matches of score 3 or 4 or completely unmatched. These are certainly from the second and third groups, which did not have enough time to accumulate enough matches. With the late addition of mobs, it is not surprising that there were a significant number of low match scores. Of the three scores, there were an additional three lambs that had three matches with a reliability of 100%. There were an additional 11 lambs that had more than five matches each with a reliability of at least 70%

Table 2. Displays the total number in class one and two of acceptable lamb matches (240) out of a total mob of 440 lambs at Andrew Slade's in 2019.

Reliability	**No Lambs**	**Average No Matches**
Class 1	111	19
Class 2	129	8
Class 3	101	3
Total Matches	341	

4.3.2 2018 results

The stud ewe flock moved through the Pedigreescan race, easily enabling the data collection the be achieved successfully in 2018. Some of the ewes had been through the race in 2017; this would have helped train others in the mob.

Three hundred forty-nine lambs achieved match scores of class one and two Table 3. There were also 205 lambs with matches of score 3 or 4, or completely unmatched

Table 3: Displays the number of acceptable lamb matches (362) out of the total mob of 554 lambs at Andrew Slade's in 2018.

Reliability	Numbers Matched	Matches	Match Percentage
Class 1	81	>10	100%
Class 2	22	>10	>75%
Class 2	176	>5	100%
Class 2	28	>5	>75%
Class 2	42	4	100%
Class 3	13	>5	>75%
Total Matches	**362**		

Between September 14-24, 2018, the Pedigreescan recorded and the average number of reads per day of 1244 in a mob of 400 ewes with a total read of 12247 over the ten days Fig.3. Between September 24 and October 2, the same mob of 400 ewes recorded, on average, 1266 reads per day with the Pedigreescan with a total read of 11398 in 9 days Fig.4.

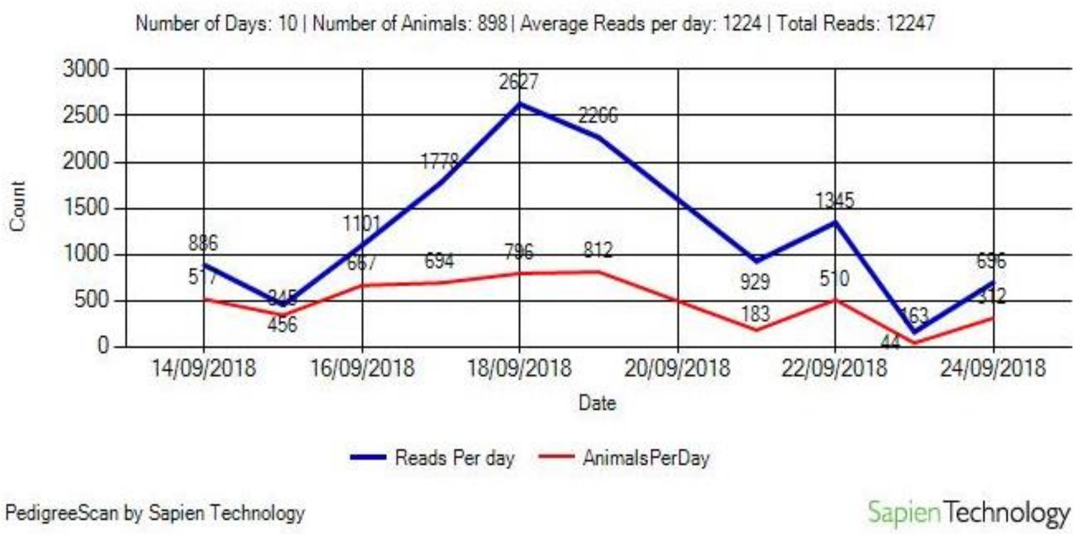

Figure 3: The Pedigreescan software created this graph by Sapien technology. Andrew Slade had 400 ewes in the mob, and the average number of reads per day was 1224 between September 14-24, 2018 (10 days).

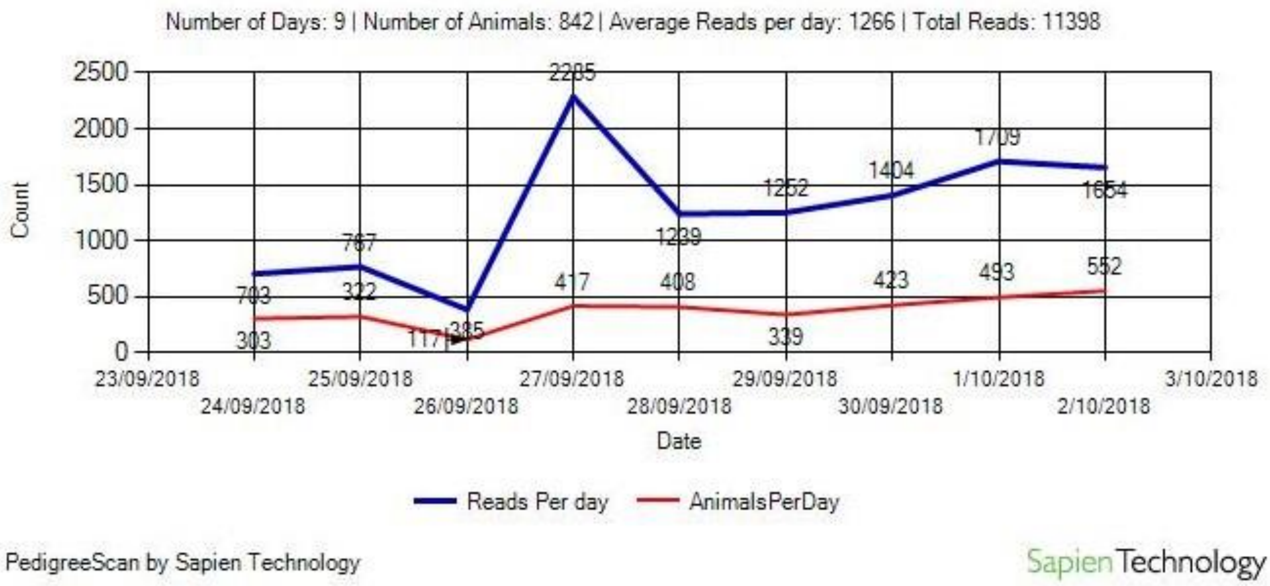

Figure 4: The Pedigreescan software created this graph by Sapien technology. Andrew Slade had 400 ewes in the mob, and the average number of reads per day was 1266 between September 24, and October 2, 2018 (9 days).

4.3.3 2018 and 2019 DNA Technology Results

A sample of the analysis by Next Generation Livestock Solutions of the pedigreescan and DNA data is shown below. It shows the ID of the lamb (progeny) and its dam from the DNA analysis and pedigreescan analysis (Panel).

The analysis checked for a match of the dam ID from both methods. YES, showed there was agreeance between the two methods. Assuming that the DNA is correct, a NO in this column indicates that the Panel result was incorrect. NA is where no DNA result was returned.

Other information: The sire ID is also shown, with NA representing a likely failure of the sire's DNA sample. DNA testing also provides the animal's status of poll horn genes. PP and PH are polled, and semi polled, with HH being horned. This is useful for breeders where polled animals are important.

The rear type (not birth type) has been reported for both the DNA analysis and from the Panel, and well as whether the rear types match. The DNA rear type will be accurate, except when a sibling has not been assigned a Dam. The Panel reliability score is then given in the last column.

Progeny ID	Dam ID from DNA	Dam ID from Panel	Dam ID Check - DNA vs Panel	Sire ID from DNA	Poll Horn from DNA	Rear Type from DNA	Rear Type from Panel	Rear Type Check - DNA vs Panel	Panel Match Reliability Score
180001		120744	NO				3	NO	2
180002	160343	160343	YES	170292	PP	1	1	YES	2
180003	160157	160157	YES	NA	PH	1	NA	NO	4
180004	110279	110279	YES	170036	PH	1	1	YES	2
180005	140315	140315	YES	NA	PH	2	NA	NO	4
180006	130268	130268	YES	170088	PP	2	2	YES	3
180007	151243	151243	YES	170006	PH	2	1	NO	2
180008	140213	140213	YES	170483	PP	2	1	NO	2
180009	160018	160018	YES	NA	PP	1	2	NO	2
180010	140056	140056	YES	170214	PP	2	2	YES	2
180011	160463	160463	YES	NA	PH	1	1	YES	2
180012	130353	130353	YES	170087	HH	1	1	YES	3
180013	150048	150048	YES	NA	PH	1	1	YES	3
180014	120744	120744	YES	170264	PH	1	3	NO	3
180015	150143	150143	YES	NA	PH	2	NA	NO	4
180016	150237	150237	YES	170264	PP	2	2	YES	3
180017	120527	120527	YES	NA	PP	2	2	YES	2
180018	150020	150020	YES	170214	PP	1	1	YES	1
180019	150209	150209	YES	170314	PH	2	2	YES	2

From the analysis, there are several conclusions that can be drawn. Tables of data summaries follow with accompanying commentary.

	Number of
Panel matches 1-3	374
Panel matches 4	108
DNA rear type fails	32
DNA Sire match fails	161

Result	Dam Matches between DNA and Panel	Rear Type Matches between DNA and Panel
YES	411	291
NO	30	191
#N/A	41	0
YES%	85%	60%
Panel inaccurate%	6%	22%
DNA Dam failure %	9%	7%
Inconsistent result%		11%

Results on the above data summaries:

As previously mentioned, the Panel results are used in the parentage analysis when the reliability of the match is three or better. Of the 482 lambs identified by the software, 374 lambs were in this range; however, 411 (85%) lambs had “YES” for their DNA and Panel Dam matches. This indicates that some of the 4-score reliability matches from the Panel may indeed be correct; however, they had just not sufficient matches to reach score 3 or better.

There were 30 Panel Dam pedigrees (6%) that did not match that of the DNA analysis, so these were incorrect predictions based on the data provided by the panel. Additionally, 9% of the progeny DNA samples failed to match with a Dam. This could either have been an issue with the Dam’s tissue sample or that of the progeny.

60% of the rear types generated by the panel matched that of the DNA, with non-returns from the Dam DNA accounting for 7%. The panel was inaccurate 22% of the time, and 11% of the results were unexplained.

This data shows that the Pedigree Matchmaker technology is pretty good (at least 85% accurate) at predicting pedigree when compared to DNA results, which we believe to be accurate. However, DNA tests do have an error rate (in this case, 9%), This could either be because the lamb or dam sample was unable to be accurately analysed, or there were dams that didn't get tested for some reason

Multiple Sires represented in one pregnancy

The DNA parentage test also shows that multiple sires may be involved in one pregnancy. This can occur when multiple rams join a ewe within a short period. This can be seen in the data that follows where normal twin births are shaded green, and twin births to multiple sires are yellow. Singles are not highlighted.

Progeny ID	Dam ID from DNA	Sire ID from DNA
180297	100494	170087
180126	100545	NA
180480	100666	170036
180375	100682	170264
180383	100682	170264
180238	101878	170036
180208	110217	170087
180362	110217	170264
180056	110270	170264
180169	110270	170264
180476	120410	170264
180004	110279	170036
180024	110321	170264
180157	110321	170264
180470	110581	170087
180452	110601	170088
180465	110615	170036
180205	110913	170088
180364	110913	170264
180425	120349	NA

In the table above, progeny highlighted in green with IDs 180375 and 180383 are twins, with Dam ID 100682 and Sire ID 170264. However, twins in yellow 180208 and 180362 share Dam 110217 but have Sires 170087 and 170264, respectively. This means that 180208 and 180362 are only half-siblings (via dam). 180362 is a half-sibling with 180375 and 180383 because of their common sire.

Of the 122 sets of twins and three sets of triplets in the DNA analysis, 44 sets of multiple births had multiple sires represented.

Not all rams are equal

In a normal syndicate mating situation, it was assumed that all rams got an equal share of the matings and subsequent progeny. However, the DNA data shows this is not the case.

Group	SireID	No of Progeny	Poll/Horn
Sire	170006	Progeny: 16	PH
Sire	170036	Progeny: 18	PP
Sire	170069	Progeny: 2	PP
Sire	170079	Progeny: 0	PP
Sire	170087	Progeny: 46	PH
Sire	170088	Progeny: 19	PH
Sire	170099	Progeny: 0	PH
Sire	170214	Progeny: 34	PP
Sire	170264	Progeny: 67	PP
Sire	170268	Progeny: 11	PH
Sire	170292	Progeny: 17	PP
Sire	170314	Progeny: 32	PP
Sire	170442	Progeny: 26	PP
Sire	170483	Progeny: 26	PP

Sires 170079 and 170099 had no progeny, whereas sire 170264 had 67 lambs. This information can identify dominant sires and those sires that were infertile or not/less inclined to mate. It can also be used to plan future matings. For example, sire 170006 may be the top sire in his drop. If he was used in a single sire mating, he may have more progeny.

If, for instance, sire 170264 was identified as a ram with moderately twisted feet, his use in a syndicate may be having a greater than anticipated negative effect in a breeding program as he has a disproportionate number of progenies.

4.3.4 DNA Technology Costs

Cost

A refurbished Sapien Technologies pedigreescan panel retailed for $3080 GST incl when this project commenced. We have proposed a lifespan of 10 years. The system is quick to set up; however, access to the data can be difficult, needing the expertise of a private consultant.

Allflex TSUs retail at $3.30 and the Parentage test from Neogen is $22 per sample. If genomic information is also required to improve the accuracy of Australian Sheep Breeding Values (ASBVs), the cost is $28.60 per test.

In the first year of DNA testing all animals (Progeny, Sires, and Dams) must be sampled to generate the parentages, however as this DNA tested progeny become sires and dams themselves, only subsequent generations need to be sampled as the DNA of parents of any new progeny are already “in the system.”

A summary of costs appears below and is reported as the total cost per pedigree.

Panel Pedigree costs incl GST	
Panel cost	$ 3,080.00
Life of panel	10 years
Panel cost/yr	$ 308.00
Setup cost/yr (2hours)	$ 60.00
Data retrieval cost/yr (2hrs)	$ 60.00
Data analysis cost/yr	$ 150.00
Total annual cost	$ 578.00
Total lambs/yr	485
Accuracy rate	85%
Lambs with pedigree	412
Total cost/pedigree	$ 1.40

1st Year DNA Pedigree costs incl GST	
Tissue sampling unit	$ 3.30
Parentage test	$ 22.00
First year costs	
471 lambs (tsu and test)	$ 11,916.30
14 sires	$ 354.20
406 dams (tsu and test)	$ 10,271.80
Sampling (3 staff for 3 hrs)	$ 270.00
Data analysis cost/yr	$ 100.00
Total first year cost	$ 22,912.30
Total lambs	471
Accuracy rate	94%
Lambs with pedigree	443
Total cost/pedigree	$ 51.75

Ongoing yearly DNA Pedigree costs incl GST	
Tissue sampling unit	$ 3.30
Parentage test	$ 22.00
Subsequent year costs	
471 lambs (tsu and test)	$ 11,916.30
Dams and sires already tested	$ -
Sampling (3 staff for 2 hrs)	$ 270.00
Data analysis cost/yr	$ 100.00
Total ongoing yearly cost	$ 12,286.30
Total lambs	471
Accuracy rate	94%
Lambs with pedigree	443
Total cost/pedigree	$ 27.75

The cost analysis above shows that although in the first year, the DNA Pedigree test is more accurate than the Panel Pedigree, it is substantially more expensive, $51.75 vs $1.40. Although in subsequent years, the DNA is cheaper ($27.75) as the dam and sire DNA is already in the system.

The benefits of the DNA test are that it is more accurate but also returns the sire and the poll/horn status. These are particularly important for breeders, who can also for an extra $6.60 upgrade to a parentage and genomic test. This allows improvement of the accuracy of their breeding values at a younger age or prediction of ASBVs for hard to measure traits such as intramuscular fat or meat tenderness.

Another advantage of DNA testing is because the sire of each progeny can be accurately predicted; breeders could use bulk matings in a stud environment that may normally use single sire matings. It can also accurately identify the sire of a first cycle joining (or AI) vs the backup sires without a need to defer the timing of backup mating.

4.4 Mackie's eID 2019

Ninety lambs achieved match scores of class one and two, with 96 lambs with acceptable lamb matched in total. The lambs were matched between September 3 and September 25, 2019. There were over 15,000 reads on the Pedigreescan during this time period.

Table 2: Displays the number of acceptable lamb matches (96) out of the total mob of 215 lambs at Iain Mackie's.

Reliability	Number matched	Matches	Match percentage
Class 1	20	>10	100%
Class 2	9	>10	>75%
Class 2	37	>5	100%
Class 2	8	>5	>75%
Class 2	14	4	100%
Class 2	2	4	>75%
Class 3	2	>5	>75%
Class 3	4	3	>75%
Total Matched	**96**		

4.5 Hood's dual-purpose crop - summer crops

4.5.1 2017 – Summer Canola

Grazing of the canola took place in the first two weeks of February 2017, with 287 lambs weighed onto the crop at an average of 40.4 kg. The lambs grazed the crop for two weeks and weighed an average of 42.7kg when they had finished grazing the canola. Gaining an average of 2.3kg over two weeks.

The second grazing of canola took place in April. Three hundred forty-three lambs grazed the canola for eight days and were removed.

Unfortunately, the canola did not recover very well after the Paraquat/grass spray in May 2017. Due to the low biomass and yield potential to canola was unable to be grazed a third time in 2017 and was not harvested.

4.6 Curwen's dual-purpose crop - Cereals

4.6.1 2017 - Barley

A 220Ha Oxford barley paddock was grazed with 2000 ewes for five weeks starting on May 26, 2017. The ewes were not weighed before or after the crop grazing due to the change in producers hosting the site.

Due to the complete breakdown of the varieties (Oxford) natural disease resistance to spot form and net form type blotch, yields were not as high as expected. Curwen's Oxford barley yields were comparable amongst all Oxford barley crops within the region that did not have sheep grazing them in 2017. Curwen's barley crops will usually yield 4-5t/ha, which is what the variety Rosalind achieved in 2017. However, final yields were 2.1t/ha from the Oxford barley in the demonstration paddock.

4.6.2 2018 – Long Season Wheat

The demonstration site at Curwen's in 2018 was in a 32ha paddock of wheat split into four, approximately equal, 8ha sections. The eastern two sections were sown to DS Pascal, while the western two sections were sown to Longsword. From there, a temporary fence was erected to divide the paddock into northern and southern halves, with the northern half were grazed by 150 lamb bearing ewes and the southern end remaining ungrazed. The paddock was grazed for 34 days by 150 lamb bearing ewes who lambed during the grazing period.

The average amount of DM consumed per ewe per day is 1.8 kg. Data collected from a Greenseeker supported observations that the sheep preferentially grazed Longsword in comparison to DS Pascal. The Greenseeker measurements are relevant because the readings were calibrated to biomass cuts taken from the same demonstration paddock. The R^2 value of 0.8083 indicates a reasonable correlation between the measured data (wheat biomass) and the Greenseeker readings.

Grain harvest yields from the Curwen PDS were very positive for the grain and graze concept. The difference between the grazed and ungrazed Longsword was minimal (150kg/ha), and the yield of the DS Pascal was higher in the grazed plots (2.04 to 1.26 t/ha) Fig.5. Poor yields in the DS Pascal variety were suspected to be due to frost damage. Grain quality analysis has not been completed. DS Pascal is the only variety (APW) that is not classified as a feed.

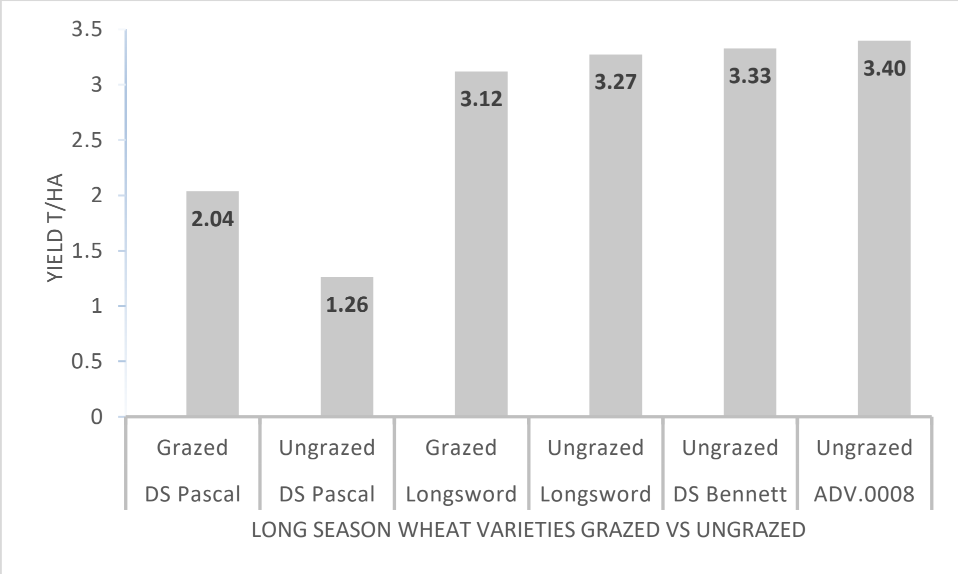

Figure 5: The grain yields (t/Ha) of the Curwen Grain and Graze PDS at South Stirlings in 2018. The paddock was sown on April 12 and harvested on December 22.

4.6.3 2019 – Wheat

On the 14th June 2019, 1100 wethers were weighed and put in a 141ha long season wheat paddock over a ten-week period. The varieties sown were Illabo, Scepter, and DS Bennett. They were pulled out of the paddock and weighed on August 23, 2019 before growth stage 31 (end of tillering). The wethers gained, on average, 1.18kg over the duration of the crop grazing Fig 4.

The long season wheat was harvested in December 2019, the final yield in the grazed was 4.06t/ha Illabo, 3.67t/ha DS Bennett, and 4.65t/ha Bennett Fig 6.

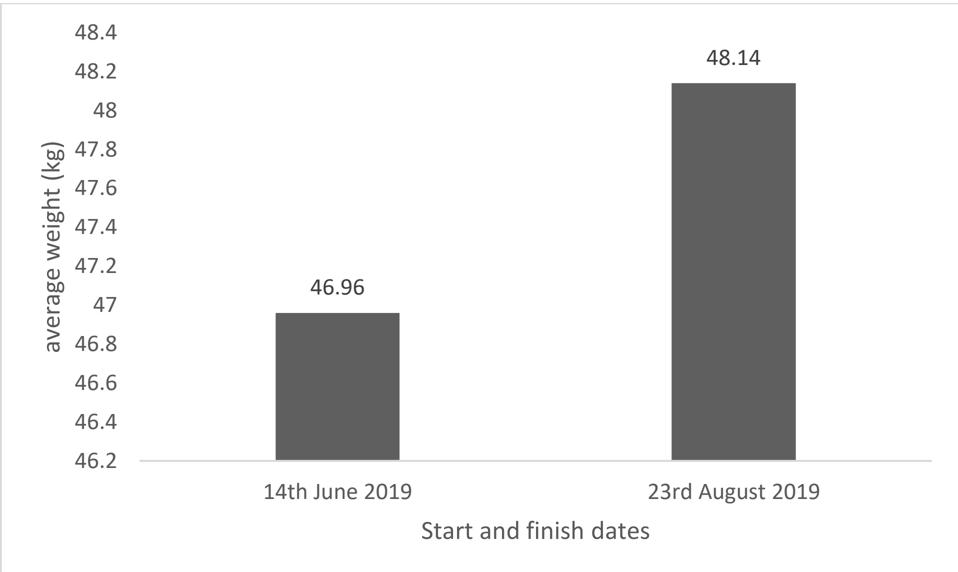

Figure 6 Live wether weight gain (kg) grazing a long season wheat paddock over a 10-week period from 14th June 2019 to 23rd August 2019. The average weight gain was 1.18kg per animal.

4.7 Beech dual-purpose crop - oats

4.7.1 2018 - Oats

The demonstration site consisted of a 7.5Ha paddock of Tucana oats, grazed by 50 wether merino hoggets for two weeks. The sheep were weighed into the paddock on July 13, at an average weight of 37.43kg, and weighed off on July 27, with an average weight of 42.70kg. The average weight gain per hogget was 5.27kg. This equates to weight gain of 0.376g per day on average. The average live weight gain across the 7.5ha was 2.5kg per hectare per day.

The oats were then locked up for the rest of the year and set aside for hay. The crop was cut when it was still quite green due to contractor availability. Final hay yield was 7t/ha, and on November 20, 2018, it was estimated to be worth $180/t which meant gross revenue was $1260/ha which included two weeks of grazing value.

An adjacent paddock of ungrazed Tuscana oats was also made into hay, which also yielded an average of 7t/ha.

4.7.2 2019 – Oats

The 2019 demonstration site consisted of a 15ha paddock of Tucana oat. Four hundred and five lambs were put on the paddock to graze for a 24-day period. The lambs were weighed into the paddock on June 18, at an average weight of 39.8kg, and weighed off on July 12, 2019 with an average weight of 41.6kg. This gave an average weight gain of 1.8kg per animal. Which gave a weight gain of 0.075gram per day on average Fig 7. The average live weight gain across the 15ha was 2kg per hectare per day.

The oats were then locked up for the rest of the year and set aside for hay. Final hay yield was 6.5t/ha; it was estimated to be worth $240/t, which meant gross revenue was $1560/ha, which included three weeks of grazing value. The ungrazed oats, however, yielded 8.5t/ha, which equates to $2040/ha. There was a $480 difference between the grazed and ungrazed oats

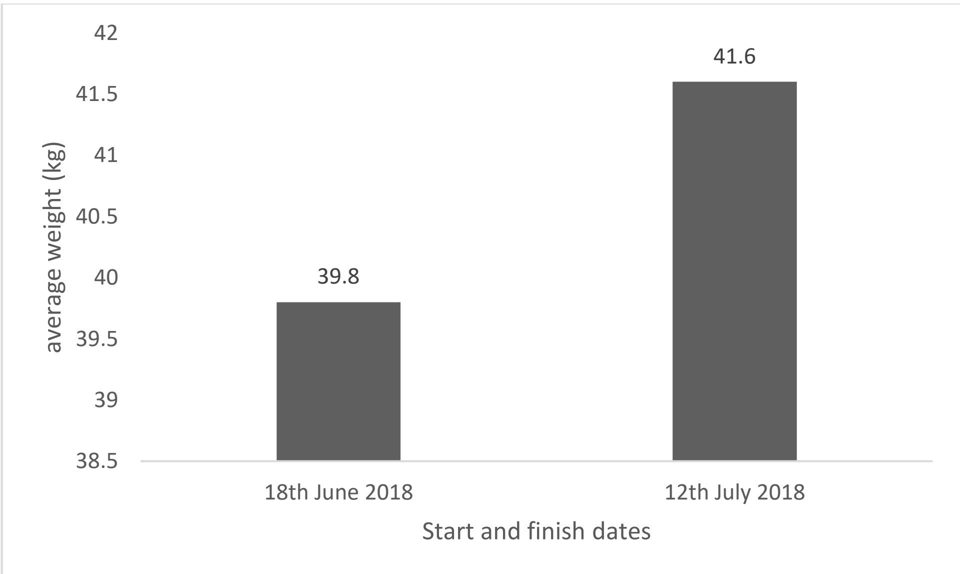

Figure 7 Crossbred lambs liveweight gain (kg) grazing an oat paddock over a 24-day period from June 18, 2019 to July 12, 2019. The average weight gain was 1.8kg per animal.

4.8 Walker dual-purpose crop – Summer Forage

The 2019 demonstration site consisted of a 67ha paddock of *Shirohie millet*; 2000 lambs were put on the paddock to graze for a 37-day grazing period. The lambs were weighed into the paddock on November 28, 2019, at an average weight of 41.80kg, and weighed off on January 3, 2020 with an average weight of 46.2kg. The average weight gain per animal was 4.4kg. This gave an average daily weight gain of 118 grams, Fig 6. The average liveweight gain across the 67ha was 3.5kg per hectare, per day fig 8.

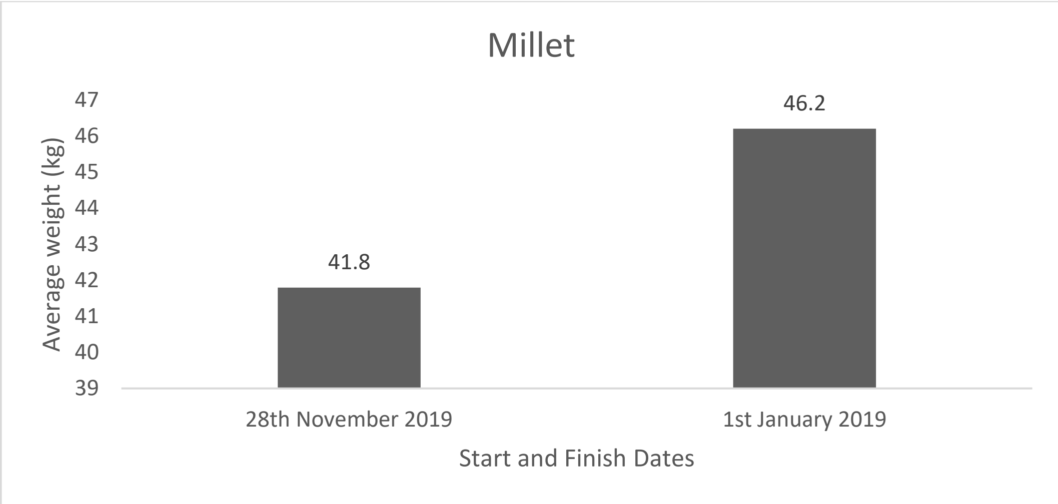

Figure 8 Crossbred lamb liveweight gains (kg) grazing a *Shirohie millet* paddock over a 37-day period from November 28, 2019 to January 3, 2020. Average weight gain was 4.4kg per animal

The *Pallaton Raphano* demonstration trial had 300 lambs grazing a 12ha paddock over a 37-day grazing period. The lambs were weighed onto the paddock on November 28, 2019 with an average weight of 33.1kg and weighed off the paddock with an average weight of 37.5kg. This equated to a an average liveweight gain of 4.4kg. The average live weight gain across the 12-hectare paddock was 2.95kg per hectare per day fig 9.

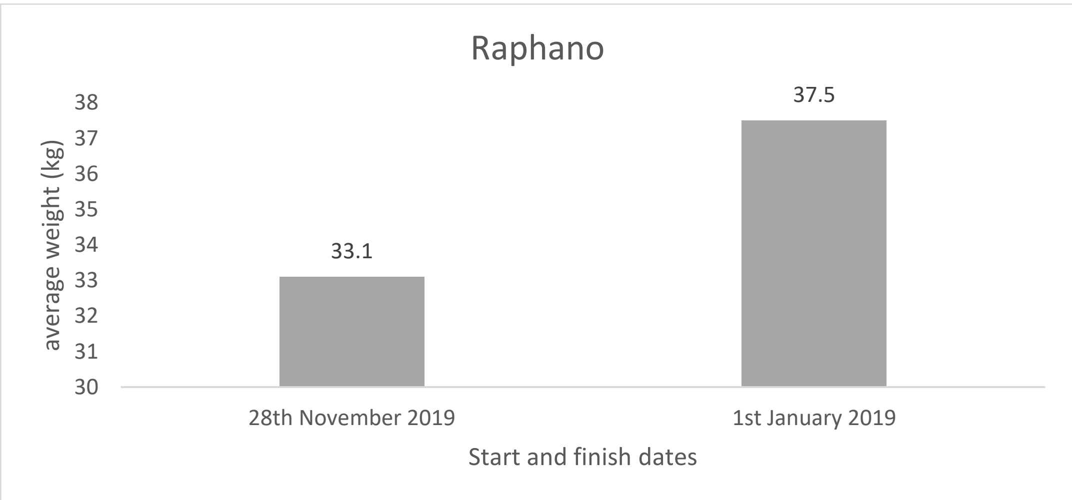

Figure 9 Crossbred lamb liveweight gains (kg) grazing a *Pallaton Raphano* paddock over a 37-day period from November 28, 2019 to January 3, 2020. Average weight gain was 4.4kg per animal.

5 Discussion

5.1 Pedigreescan eID Technology

5.1.1 Kate & Jeff Stoney's eID demonstration

The first farmers to use the pedigreescan panels were Jeff and Kate Stoney from Gnowellen in WA 80km east of Albany. Their Merino ewes and lambs were given free access to a lick feeder in a large outer yard associated with the sheep handling facilities before installation of the pedigreescan unit. Although there was considerable feed available in the paddock, the sheep did use the feeder. The entry gateway was narrowed before the installation of the panel to make the sheep less afraid of accessing the yard once the panel was installed.

On May 31, 2017, Jonathan England from AgInnovate and Kate Stoney set up the Sapien pedigreescan panel in the gateway to the yards already being used by the sheep to access the feeder. There was another set of gates in another part of the feeding yard that we used to force the sheep into the yards so that the only way out was through the pedigreescan setup.

The problem that was found with the setup was that once all the sheep were in the yards, the leader sheep that were first through the panel turned straight back around the corner and ended up next to the mob. As a result, the decoy sheep disappeared, and the sheep stopped walking through. Putting a wing fence up straight out from the corner of the yard alleviated the short-term problem with sheep walking out. The fence was then taken down so that ewes and lambs would not get separated on their way in, and as a result, the wing effect was lost.

The Stoney's found that the sheep would not go into the yard by themselves, so Kate pushed the sheep into the yard through the alternative entrance daily and let them walkout by themselves. This did get tag reads by force, but as the data shows, the number of accurate reads was low.

Kate also felt that the beep emitted by the unit as each tag was read, scared the sheep. Stoney's went away, and during that time, the battery on the unit went flat. When they returned, they found the sheep walking freely through the unit. It was assumed that they had become very familiar with the setup; however, when the battery was changed, the beep from the unit once again became a disincentive for the flow of sheep.

The Pedigreescan recorded ewes and lamb matching for a 10-week period between May 31, and August 8, 2017. Ample time was allowed for matching ewes and lambs; the success rate was very poor, only achieving 9% mothering. The mob of sheep had to be manually chased into the yarding area. However, they were then able to leave the yards via the Pedigreescan raceway. 100-day lamb weights were recorded, but the relationships to the key and bottom performing ewes could not be traced. A few of the problems encountered with using the pedigree scan, which possibly caused the sheep's reluctance of walking through on their own were:

1. Adequate levels of feed in the paddock means the incentive to visit the self-feeders or hay bales was not high enough.
2. Ewes are young (maidens) and have had limited interactions with yards, sheds, and man-made structures.
3. The design of the "feed yard" was not ideal in 2017
4. The loud beep the reader made as they passed through

Despite running the *Pedigreescan* for ten weeks, Jeff and Kate were only able to achieve 35 class one and two matches from 398 lambs in the mob. This made it hard to match the poor performing lambs (100-day weight) with their mothers.

Without confidence in the matchings, we were not able to determine the bottom 20% of ewes for their chosen performance trait. The trait that Kate & Jeff wanted to select for was the 100-day lamb weaning weight. We have identified the issues with the poor performance of the *Pedigreescan* in 2017 at Stoney's.

Kate and Jeff's view of using eID technology in 2017 were:

1. The *Pedigreescan* was very labour intensive, with pushing ewes and lamb's through the *Pedigreescan* on many occasions to increases recordings.
2. They were reliant on the consultant to manage data, so it was not user-friendly, and the farmer couldn't set up their own parameters, i.e., could not itemize ewes into the top 20% of the mob in relation to certain traits.
3. Having to buy an additional computer program to access data and, therefore, reliant on a consultant.

They are interested in looking at alternative mothering up technologies new to the market, such as WIFI initiated over *Pedigreescan* as a more applicable method for commercial based sheep enterprises.

eID tags from various companies were used to look at longevity, readability, and ease of application at this demonstration site. They were very impressed with the tags and preferred multiple automatic taggers over single use for saving time during application.

5.1.2 Andrew Slade's eID demonstration

On August 24, 2017, Andrew Slade, under the guidance of Jonathon England from *Aginnovate*, set up *Pedigreescan* for his first and second tier *Greeline* stud ewe flock. Slade's property is in Kendenup WA, 75km northwest of Albany. The scanning unit was on a creek line in a small paddock where the sheep needed to pass through regularly. In just over two weeks, the unit recorded over 20,000 passes from the 300 ewes and 440 lambs.

There was a greater success using *Pedigreescan* at Slade's demonstration site compared to Stoney's. Two hundred forty lambs achieved match scores of one and two. Scores of class one and two give accurate results. This was a great result with all but 18 of the 266 lambs from the first mob matched. These sheep moved through the race easily and regularly. This was attributed to a better set-up of the race and possibly sheep that were more experienced with machinery and handling because they were stud ewes.

The same mob of 400 sheep was again recorded in 2018 between September 14 and October 2, 2018. There were 23,645 readings recorded over a 19 Day period in 2018.

There was a far greater success using *Pedigreescan* at Slade's demonstration site in 2017, with 90% of ewes and lambs being matched up. In 2018, 65% of ewes and lambs were matched. The decrease in reliable matches was likely due to the size of the lambs as they were older and less reliant on their mother.

The sheep at the Slade's moved through the race easily and regularly in both 2017 and 2018, which resulted in highly significant readings between the mother and lambs. Some of the ewes would have been through the race in 2017, which may have attributed to training the others in the 2018 mob.

At shearing time, the use of eID tags was further utilized in the Slade farming enterprise to gather and record wool quality information in their stud ram flock. This information will provide "extra" data to the stud ram buyers and will potentially lead to increased ram prices for the Slades.

It is difficult to do a cost-benefit analysis for the extra information gathered for Andrew's stud rams. Any potential increase or decrease in sales prices could be due to multiple factors. However, Andrew can at least note feedback from his repeat ram buyers. Andrew will be able to determine if the extra information was either positive or negative or possibly unnoticed.

In summary, eID technology made the process of testing and weighing the ram's wool, easy, accurate, and efficient. This meant that Andrew Slade could justify the time and expense of collecting the data because he believed the return on investment was greater. Previously, with the manual reading of ear tags, Andrew deemed this data not worthwhile to collect for his ram buyers

DNA Parentage technology

In 2018 Andrew used DNA technology to generate the pedigrees of his lambs. This involves taking a tissue sample from all the sires, ewes, and lambs. The DNA matches are then made, returning the parentage and poll horn status of each animal.

There are two DNA collection options, blood cards and tissue sampling units. Andrew chose the Allflex tissue sampling units (TSU), which use a special set of pliers to take a small sample of ear tissue and seal it in a vial. The TSUs have a barcode that is matched to the EID tag of each sheep.

The samples were then sent to Neogen for analysis. There were 14 sires, 406 dams, and 471 lambs submitted.

The data found that the Pedigree Matchmaker technology is pretty good (at least 85% accurate) at predicting pedigree when compared to DNA results, which we believe to be accurate. However, DNA tests do have an error rate (in this case, 9%), This could either be because the lamb or dam sample was unable to be accurately analysed, or there were dams that didn't get tested for some reason.

In conclusion, DNA parentage technology is far more expensive than using a Pedigree Matchmaker system, $27.75 in an ongoing breeding program vs $1.40 per progeny with a valid ewe pedigree.

However, the information from a DNA parentage test that can be gained by a breeder, relating to the progeny, dam, and sire from a breeding event, is likely to be recouped through making better decisions and hence improved genetic progress. This would especially be the case when genomic testing (where available) is included along with the DNA parentage test.

For a commercial breeder, the Pedigree Matchmaker technology is a cheap way to compare litter size (gained from pregnancy scanning) with lambs reared. This information can then be used to predict maternal efficiency, including kilograms of lamb weaned per ewe.

However, it is the attention shown to detail that drives the benefit of these technologies. If ewes do not walk through the Pedigree Matchmaker system, it is not in place long enough, the lambs are too old and thus more independent, or the battery runs flat and is not checked, then the number of matches, reliability and resulting benefits will be poor. Similarly, if the tissue sampling process is not of a high standard, the DNA results may be compromised, leading to a greater cost per accurate pedigree.

As with all data collected, whether it be bodyweight, micron, fat depth, or parentage. Unless selection decisions are made to utilise the information in the pursuit of a breeding objective, data is just being collected for data's sake.

5.1.3 Iain and Andrew Mackie's eID demonstration

In 2019 Iain and Andrew set up the pedigreescan on their property in Mt Barker WA, 60km northwest of Albany. The lambs were born in June 2019 and were three months old at the time of scanning. They resulted in 53% reliable matches over the 6-week scanning period (September – October 2019).

Overall, the Mackie's found the Pedigreescan easy to set up and use; however, they did need to use livestock consultant Jonathon England to determine the results as they found them difficult to interpret.

One issue the Mackie's had during the demonstration period was similar to the Stoney's in 2017. They found that they were not getting enough reads naturally during the day and needed to push the sheep through, from paddock to paddock, to manually boost recording data.

Andrew Mackie's view of using the technology in 2019 is similar to the Stoney's; in it was labour intensive for the results they received and needing to use a consultant to interpret the data was a negative.

Overall, Andrew did not feel the Pedigreescan technology fit into their farming system. They, however, will continue to use eID for data information on lamb gaining weights and wool data such as micron and fleece weights. They aim to use eID information and data to identify and cull the worst performers and to continue to keep the best performers for breeding.

5.2 Dual Purpose Crops

5.2.1 Hood's dual-purpose crop – Forage Canola

In 2017 a forage canola crop was able to successfully get two grazing periods off a very small paddock (10 Ha) of winter-type canola in South Stirling WA, 75km northeast of Albany. The 970CL canola was sown with 100kg/ha of k-till plus fertiliser. It was expected to be able to graze the canola three times over the year; however, an unusually dry April/May prevented an optimal recovery from the second grazing. Some of the canola plants were uprooted by the sheep, which reduced plant numbers and yield potential. Canola plants were well established at the time, and therefore, it was not grazed prematurely. The reasons for the sheep uprooting the canola plants are unclear, but it is possibly because of the sandy, structureless soil.

Grazing of the canola took place in the first two weeks of February 2017, with 287 lambs being weighed onto the crop at an average of 40.4 kg. The lambs grazed the crop for two weeks and weighed an average of 42.7kg when they had finished grazing the canola — gaining 2.3 kg on average over two weeks. The second grazing of canola took place in April 2017. Three hundred forty-three lambs grazed the canola for eight days and were removed; however, the weights were not measured during this grazing period.

The canola did not recover very well after the Paraquat/grass spray in May 2017 (500ml/ha Clethodim, 1Lt/ha Propyzamide, and 1Lt/ha Paraquat). In hindsight, the chemicals selected to control the weeds were too aggressive and caused unacceptable amounts of reduction in biomass. The canola was not able to be grazed again for the third time in 2017, and the grower was not able to harvest the crop because of the extremely low yield potential.

Overall the canola grazing trial was not a success at Hood's farm in 2016-17. The concept of winter canola being grown in the lower great southern still needs exploration. On the positive side, the canola survived over the tough, dry summer period to produce some very early-season feed for grazing. The downside was that plant numbers were reduced after grazing due to whole plants being pulled up by the lambs. This left an already sparse plant population, with even fewer plants per square meter. The lack of plant competition from the canola meant that weed numbers proliferated, and the farmer needed to apply chemicals to address the problem. Unfortunately, the chemical mix, in combination with a dry and tough part of the growing season, did unrecoverable damage to the canola crop, and this prevents the crop from being harvested. Further demonstrations should look at increasing the canola seeding rate and growing on heavier, more fertile soil. Plant establishment numbers were low at South Stirling's partially due to the non-wetting nature of sandplain soils.

5.2.2 Curwen's dual-purpose crop – Cereals

2017-barley

The second dual-purpose site was at Curwen's property in South Stirling 70kms northeast of Albany. In 2017 a 220Ha Oxford barley paddock was grazed by 2000 ewes for five weeks starting on May 26. The ewes were not weighed before and after the crop grazing period due to the change of producers hosting the site.

Due to the complete breakdown of the varieties (Oxford) natural disease resistance to spot form and net form type blotch, yields were not as high as expected. This poor yield result is not thought to have any correlation to the grazing that occurred in May and June. Curwen's Oxford barley yields were comparable amongst all Oxford barley crops within the region that did not have sheep grazing them in 2017. Curwen's barley crops will usually yield 4-5t/ha, which is what the variety Rosalind achieved in 2017. However, final yields were 2.1t/ha from the Oxford barley in the demonstration paddock.

In summary, the grazed Oxford barley performed the same as un-grazed Oxford crops in the region. The poor yields were variety specific and not because of a negative response to the 5-week grazing period.

2018-Wheat

The shortest season length wheat variety in the demonstration was DS Pascal. Based on the significant yield improvement in the grazed treatment, it can be reasoned that the ungrazed treatment was more severely damaged by at least one frost event. The final yield of 2.04 (t/ha) in the grazed DS Pascal area is still a very poor result for the South Stirling region. Frost was most probably a major constraint on both DS Pascal treatments as well as the dry conditions after seeding.

Previous work from the Grain and Graze projects have indicated that wheat flowering dates can be set back a maximum of two weeks after heavy grazing. The sheep in this trial did not heavily graze the DS Pascal due to a preference for the Longsword variety. It is unclear if heavy grazing would have delayed the flowering time enough to avoid the frost damage in DS Pascal. For an early sowing date, it would be less risky for farmers to sow a true winter type wheat that has either vernalization and/or photoperiod triggers to initiate the reproductive phase.

2019 - Wheat

On April 20, 2019, long season winter wheat was again sown for the Curwen's demonstration site. Illabo, DS Bennett, and Scepter were sown on April 20. The wethers were placed into the paddock on June 14 and left to graze over a 10-week period. The delayed time to stem elongation, particularly in the Illabo, meant the sheep had a ten-week grazing period and a good feedbase without compromising final yields. The wether's gained, on average 1.1kg over that grazing period. Despite the dry finish to the season, the final yields held up in comparison the last year's data. From these results, the Curwen's are going to continue to adopt the Illabo winter type wheat for grazing in the future.

The Curwen family were happy with the experiment to sow wheat earlier than "normal" and graze it once over the past three years. Both 2018 and 2019, were very tough seasons for local farmers who fed out record amounts of grain to maintain livestock condition. Grain prices were also very high due to drought conditions across the country during this period. This made the green feed even more valuable. During the June-July period, there was no other green feed available on the farm for the ewes to eat. The Curwen's believe that having significant areas planted to long-season wheat is one way they can plan for and affordably mitigate drought-like or simply dry seasonal conditions.

5.2.3 Beech's dual-purpose crop - Oats

There were some interesting observations about the Tuscana oats in comparison to Bannister oats, which was grown in other paddocks in 2018. Tuscana stayed greener for a lot longer due to its long season length. The grower felt this is a very beneficial trait for the Tenterden/Kendenup area, where they often have longer springs and cool temperatures during the October/November period. Despite a late break to the season, the Tenterden area ended up having an excellent season due to the long spring and cool finish.

In 2018 after grazing the 7.5ha oats paddock for two weeks, all the hogget's got the scours after being on the rich feed source despite being up to date with drenching. Jarrod Beech was unsure how to solve this problem and sees it as the biggest drawback to the grazing oats system. Jarrod investigated grazing the oats earlier in 2019 to make sure the crop did not build up too much biomass before the sheep graze it. Jarrad speculated that keeping the biomass shorter for longer might help the sheep become accustomed to the rich feed source.

There appeared to be little difference between the grazed and ungrazed paddocks of Tuscana oats in 2018 with excellent yields and worked economically for the business with returns of $1260/ha of gross revenue for the hay and two weeks of grazing value.

. While grazing crops improved enterprise diversity by specifically grazing the oats in 2019, it did impact on profitability. In summary, Jarrod plans to continue growing oats as a dual-purpose hay or grain and graze crop into the future.

5.2.4 Walkers dual-purpose crop – Summer Forage

During 2019, a grazing demonstration on *Pallaton Raphano* was carried out in Manypeaks, WA. Producer observers and demonstration hosts witnessed multiple cattle grazing events on the paddock at large carrying capacity. Jeremy Walker was one of our members who ordered the seed and planted it in October 2019. He also planted a 67ha paddock of *Shirohie millet*.

Both mobs of lambs gained 4.4kg in the 37-day grazing period on both the *Pallaton Raphano* and *Shirohie millet* paddocks. The weight gain per hectare per day was 2.95kg in the Raphano and 3.5kg in the millet. Visually there was more biomass in the millet paddock compared to the Raphano (Appendix 1 and 2). Considering the dry period, where less than 10mm of rain fell between seeding (Oct 3, 2019) and January 3, 2019, Jeremy was happy with the liveweight gains of both forage crops. Their remaining livestock was on barley stubble.

Considering there was little rainfall over summer in 2019/20, the green feed Jeremy had grown was valuable for his mixed farming enterprise. The rainfall data shows there was 21.5mm in October 2019, 4.6mm in November, and 4.5mm in December. The cost of both the millet and Raphano seed was approx. $100/ha and $15/ha for fertiliser.

Growing alternate summer crops means Jeremy can grow cost-effective feed, which will be available to their livestock during the summer-autumn period when feed is normally scarce. The Walker's will continue to look at different ways summer forage crops and dual-purpose crops can work within his farming systems to boost his profitability and diversify his enterprise.

5.2.5 Summary of crop grazing

To summarise despite some yield loss, not always due to grazing, most of the demonstrations that were harvested had minimal yield penalties. Other factors need to be considered when looking at these results regarding the success of crop grazing. The 2018 and 2019 season both had dry starts to the year. June was the break of season for most areas in both years. This meant there was minimal green feed available, with most growers still feeding sheep into July/August. The Curwen's and Beech's were both able to graze their green crops between May and July which reduced their feeding costs. Green feed is a valuable source and the cost benefits of crop grazing must be considered rather than just looking at losses through yield penalties.

Table 3. shows the summary of each of the demonstrations trial results from all years. Results show, time spent grazing average weight gain and yield loss.

Location	Host	Year	Sheep Type	Crop type	Time grazing	Average weight gain g/day	Yield Loss	Comments
South Stirling	Ashton Hood	2017	Cross bred Lambs	970CL Canola	14 days (Feb)	0.164g	Not harvested	Chemical damage did not harvest
South Stirling	Reece Curwen	2017	Marino Ewes	Oxford Barley	5 weeks (May)	n/a	None-Yielded same as ungrazed Oxford.	Low yields from disease in Oxford variety in 2017.
South Stirling	Reece Curwen	2018	Lamb bearing ewes	DS Pascal & Longsword	34 days (June)	1.8kg DM consumed	150kg/ha	frost event(s)
South Stirling	Reece Curwen	2019	Crossbred Wethers	Various LS wheats	10 weeks (June)	0.015g	0kg/ha	minimal yield penalty from grazing
West Kendenup	Jarrad Beech	2018	Wether hoggets	Tuscana Oats	14 days (July)	0.376g	0kg/ha	no yield penalty from grazing
West Kendenup	Jarrad Beech	2019	Cross bred Lambs	Tuscana Oats	24 days (June)	0.75g	2t/ha	Significant yield loss on 2019.
Kojoneerup	Jeremy Walker	2019	Cross bred Lambs	Shirohie Millet	37 days (Nov)	0.118g	n/a	green feed available during autumn
Kojoneerup	Jeremy Walker	2019	Cross bred Lambs	Pallaton Raphano	37 days (Nov)	0.118g	n/a	green feed available during autumn

5.3 Communication and Extension

Three demonstration/workshop events were held over the 3-year duration of this project. The first event held was a part of our inaugural "Livestock and technology updates" event on July 21st with 130 in attendance. The event was very successful with a large range of speakers and physical on-farm demonstrations. We had presentations from consultant John-Paul Collins regarding the implementation of eID technology and walk-over-weighing systems. John-Paul Collins also presented a case study of "sheep handling technology: economic rationale and workplace benefits." At a practical level, farmers saw sheep handling gear demonstrated from *Tru-test*, *Tupari,* and the machinery developed by the Slade family themselves that highlighted how and where eID technology could be useful in their sheep operations.

The second event was held on July 20, 2018. An afternoon field walk was held at the Curwen grain and graze demonstration site. Fifteen farmers attended and were able to visually see the significant difference between the grazed and ungrazed sides of the paddock. Kirsty Smith, a local agronomist from Landmark, presented on the day and gave agronomic advice and background on each of the varieties. The demonstration in 2018 looked at two wheat varieties in DS Pascal and Longsword. The sheep favoured grazing the Longsword in comparison to the DS Pascal. This observation was backed up by the NDVI readings taken at different intervals.

The third event was held on June 19, 2019 in Kendenup. It was held as part of a Smart Farm technology workshop, where we heard from Andrew Slade on farming in the digital ages and Geoff Duddy, whose presentation was on Technologies to improve livestock efficiencies.

Another demonstration was held on June 13, 2019; Jarrad Beech and Nathan Dovey (SCF) were invited to speak to WA College of Agriculture -Denmark students about Jarrad's experience in grazing oats and making hay. The students have been growing their own oat crops at the school farm for the last few years. They wanted to improve their grazing strategies. Jarrod was able to provide practical advice to the students and farm manager during the presentation whilst answering questions.

The project results were extended in the Stirlings to Coast newsletters with articles on the demonstrations sites, and presentations have been given at the annual trial review days.

6 Conclusions/recommendations

The project was successful in achieving its outcomes, and many of our growers will continue to look at ways they can incorporate eID technology and dual-purpose cropping into their farming enterprises. The adoption rates of eID technology increased by 37% by the end of this three-year project. Crop grazing adoption also increased by 19%. All demonstration hosts have seen the benefits of the technique/strategy they were show-casing (eID tags or Grazing crops). Both eID tags and grazing crops can increase business diversity and profitability now and in the future. Ongoing research and information dissemination will be critical to ensuring further adoption of these practices occurs.

Costs and costs fears are a pain point for many producers. Setting up new technology on-farm can be a costly exercise in both time and money to producers. However, the actual cost of technology adoption is often less than producers have envisaged. Access to specialised consultants will help producers identify their farming system needs in a cost-effective and timely manner. Adoption of new farming strategies and technology needs to be uncomplicated for producers to adopt them in large numbers. More demonstrations and analyses are needed to help improve flock management, particularly in terms of reproductive performance and other genetic improvements. Growers need to be able to quantify the cost of data to be able to utilise the full benefits of eID technology in their livestock enterprise.

Dual-purpose cropping can be an important part of mixed farming systems in the southern HRZ. When applied correctly, producers will be able to carry more livestock with minimal losses to their grain production. There is a need for a shorter winter type variety that will fit into our environmental conditions.

Many of our growers currently have a canola-barley dominant cropping rotation. Barley is more profitable than wheat in our region as a grain only crop, and therefore a winter-barley variety would be a perfect option for grazing crops. Dual-purpose barley would be preferable over wheat for our growers for its ability to tiller, which helps compete with annual ryegrass weeds and produces greater biomass earlier in the season than wheat.

Dual-purpose cropping (winter season) offers producers an opportunity to increase profits in two ways. Firstly, by carrying more livestock because they are confident of feeding animals during summer and autumn. Secondly, having livestock ready for the market outside of peak supply times, which allows producers to achieve higher prices.

Southern HRZ growers of WA have a greater opportunity to finishing lambs outside of the peak selling seasons because of our cool, wet finishes to the growing season. In addition, increased summer rainfall events are providing opportunities to grow summer crops, which can produce feed much cheaper than supplementary feeding grain or hay. Producers typically calculate whole-farm stocking rates based on their ability to carry stock over the autumn period. There are many new species and varieties of summer forage crops available. We need ongoing research and demonstrations on how to grow summer crops in southern WA to reduce the risk for producers. There is a need to develop specific agronomic summer cropping management packages for growers within a 50km radius of Albany WA. This area is especially suited to summer crops on a consistent basis due to rain falling more consistently year-round.

7 Appendix

Appendix 1. *Shirohie millet* crop before grazing 28th November 2019 at Jeremy Walker's – Green Range, WA.

Appendix 2. *Pallaton Raphano* crop before grazing 28th November 2019 at Jeremy Walker's – Green Range, WA.