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Participatory research evaluating and demonstrating the impact of green feed (particularly Lucerne) on sheep conception.

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Abstract

Agriculture Victoria in collaboration with MLA established a total of 32 commercial farm demonstrations sites in Victoria, New South Wales and South Australia between 2013 and2017. The project aimed to investigate the effects of short term flushing with green feed (including lucerne), or lupins, and long term flushing with lucerne on ewe conception (ewes pregnant / 100 ewes joined) and reproductive rates (lambs scanned / 100 ewes joined) compared to ewes grazing typical dry pasture traditionally used at individual demonstration sites. Over 22,000 crossbred, composite or merino ewes (n=600-900 per demonstration site) were joined between late December and March for an autumn/winter lambing. The ewes were divided randomly between the following treatments. Phase 1 (2013-2014): (1) control; graze typical dry pasture available throughout joining; (2) short flush; graze any green feed one week prior to joining and one week into joining; (3) control plus lupins; graze typical dry pasture plus supplement with lupins for one week prior to joining and one week into joining. Phase 2 (2015-2017): (1) control; graze typical dry pasture available throughout joining; (2) short flush; graze lucerne one week prior to joining and one week into joining; (3) long flush; graze lucerne one week prior to joining until the end of joining or for a minimum of five weeks.

This project showed that flushing ewes by providing a green feed one week prior to joining and one week into joining can improve lambing percentage through an increase in multiple ovulations and ewes pregnant. The information obtained suggests there is no negative impact on ewe reproductive efficiency when grazing on lucerne throughout joining compared to a short flush or grazing on typical dry pasture.

Executive summary

Providing ewes with nutritional supplementation prior to joining, termed as 'flushing', can improve lambing percentage through an increase in ovulation rate.

The aim of this project was to demonstrate and validate scientific research investigating the impact of short and longer term flushing with green feed (including lucerne) on commercial farms using grazing management 'typical' to that farm.

Agriculture Victoria and MLA co-funded establishment of total of 32 commercial farm demonstrations sites in Victoria, New South Wales and South Australia between 2013 and2017. The project aimed to investigate the impact of short term flushing with green feed (including lucerne), or lupins, and long term flushing with lucerne on ewe conception (ewes pregnant / 100 ewes joined) and reproductive rates (lambs scanned / 100 ewes joined) compared to ewes grazing typical dry pasture traditionally used at individual demonstration sites. Over 22,000 crossbred, composite or merino ewes (n=600-900 per demonstration site) were joined between late December and March for an autumn/winter lambing. The project included two phases with treatments described as following:

Phase 1 (2013-2014)

1. Control: Control group graze typical dry pasture throughout joining
2. Green Feed Short Flush: graze green feed one week prior to joining and one week into joining
3. Control Plus Lupins: 0.3-0.5 kg/hd/day as a supplement from one week prior to joining until one week into joining

Phase 2 (2015-2017)

1. Control: Control group graze typical dry pasture throughout joining
2. Lucerne Short Flush: graze lucerne one week prior to joining and one week into joining
3. Lucerne Long Flush: grazing the lucerne source through the joining period for or a minimum of 5 weeks

Grazing Lucerne, or other green feed, for seven days prior to joining and seven days into joining was sufficient to flush naturally mated ewes at 17 of the 30 sites monitored with a dry feed control treatment. The number of ewes pregnant and number lambs scanned was higher, compared to ewes grazing the traditional dry pasture available at joining in late December to March for an autumn or winter lambing.

In Phase 1, the demonstration project showed a reproductive rate advantage for the short term flushing on green feed compared to grazing ewes on dry pasture. There was a consistent trend with 20 of the 22 commercial properties in 2013-2014 displaying an increased reproductive rate on green feed. Of these 20 sites, 13 showed a statistically significant increase in reproductive rate ranging from 10 to 33 more lambs scanned per 100 ewes joined, compared to grazing ewes on typical dry pasture.

Conception rates in 2014 significantly increased on three of 15 sites, ranging from 4 to 13 extra pregnancies per 100 ewes joined from grazing ewes on green feed short term for two weeks compared to typical dry pasture.

Ewes fed lupins responded at five of the eight sites with an increase in reproductive rate ranging from 8 to 21 more lambs scanned per 100 ewes joined compared to the ewes on dry feed. This response was not as high as the response of the ewes flushed on green feed seven days before and seven days after joining.

In Phase 2, three of the eight sites showed a reproductive rate advantage in ewes grazed on lucerne throughout joining ranging from 16 to 47 more lambs scanned per 100 ewes joined compared to those on dry feed.

The largest influence on increasing reproductive efficiency from flushing short or long term on green fed was through having more ewes producing twin foetuses. Overall there were more pregnant ewes at some sites, however this was less of an influence on reproductive efficiency.

There appeared to be no disadvantage to ewe conception rate or reproductive rate from grazing lucerne throughout joining compared to a short flush on the majority of the sites as none of the 10 sites recorded a reduced reproductive rate and only one site recorded a reduced conception rate compared to typical dry feed.

Ewes grazing lucerne throughout joining achieved an increase in reproductive efficiency for conception rate at three sites and reproduction rate at three of the ten sites where a long flush was compared with a short flush. This indicates that there may be benefits to joining on lucerne longer than the short flush in some cases, however it was not within the scope of this project to identify the circumstances under which a benefit may be derived from the long flush.

The reproductive response to increased nutrition from green feed appears to be independent of liveweight at joining, which was also observed by Killeen (1967). It appears to be similarly independent of condition score.

There was a significant change in liveweight observed between treatments and between each weighing within a treatment at the end of the short flush and at the end of joining for most sites. Change in liveweight during the flushing period does not appear to influence conception and reproduction rates as there was considerable variability in the response in conception and reproduction rate.

Where ewes are in heavier condition it would be expected flushing may have less influence on reproduction efficiency and this demonstration has generally supported this belief, although the site with highest initial liveweight and condition score did show a significant increase in the conception rate for the lucerne longer flush treatment over the short flush treatment.

Three demonstration sites in Phase 2 of this project joined a proportion of maiden merino ewes aged approximately 15 months along with adult ewes on dry pasture and short or long flush on lucerne. At these sites, the maiden ewes showed a similar response as the adult ewes to flushing.

Although not analysed, it appears there was no apparent relationship observed between feed quality of the green feed used for flushing and the magnitude of the response in reproduction efficiency.

Implementing a simple but effective grazing management strategy that can provide a short term flush can increase lamb production and profit through generating a higher number of multiple births. The opportunity cost of flushing ewes versus finishing lambs or growing out weaners is a factor that needs to be considered prior to joining. For example, if there is a lower available feed base due to seasonal conditions then it could be more profitable to flush ewes than finish lambs. The benefit of flushing is an increase in the number of lambs born, but this requires a greater need to manage nutrition and mob size effectively for maximum lamb survival.

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1 Acronyms and Abbreviations used:

Composite	Composite breed
Control	Graze typical dry pasture available
Control Plus Lupins	Graze typical dry pasture available with supplement of 0.3-0.5 kg/head/day lupins for one week prior to joining and one week into joining
CR	Conception rate (ewes pregnant per ewes joined)
CS	Condition Score
Green Feed Short Flush	Graze any green feed available for one week prior to joining and one week into joining
kg DM/ha	Kilograms of dry matter per hectare
Lucerne Long Flush	Graze lucerne one week prior to joining and throughout the joining period or for a minimum of five weeks
Lucerne Short Flush	Graze lucerne one week prior to joining and one week into joining
Merino	Merino breed
MLA	Meat & Livestock Australia
RR	Reproduction rate (lambs scanned per 100 ewes joined)
Wt	Body live weight
1st X	First cross

2 Background

Improvement in ewe reproductive capacity can be achieved by increasing ovulation rate, which is readily affected by nutrition (Robertson *et al.* 2006). This can be achieved by 'flushing', which is the grazing management practice of providing a high quality nutritional supplement (high energy or protein) for a short period prior to joining to increase ovulation rates (Pearse *et al*. 1994). This in turn helps to increase the percentage of multiple births and overall lambing percentage.

Several green feed sources and lupins have been successfully used to flush ewes, however lucerne is particularly suited for Australian conditions as it can provide high quality feed when most other pasture have dried off and lost their nutritional value. Utilising available lucerne or other green feed to elicit a flushing response also tends to cost less compared to using a grain such as lupins. Lupins are traditionally fed at a recommended rate of 0.5 kg/hd/day and are not readily available in all locations. The flushing response can furthermore be achieved from just a short period of grain supplementation (Knight *et al.* 1975) or pasture ([A]Robertson *et al.* 2015), which can substantially reduce the quantity of feed required and hence be highly desirable from a practical and economical viewpoint.

A number of recent research studies have found that short term flushing of ewes using green feed can increase reproductive rates. EverGraze, a national research, development and extension project conducted a study at Wagga Wagga during 2006-2010 investigating the short term flushing of synchronised and unsynchronised ewes grazing summer active perennials (lucerne, chicory) versus lupins versus dry phalaris pasture. Ewes flushed on lucerne or chicory increased ovulation by 10% and up to 22% (Robertson *et al.* 2013). King *et al.* (2010) undertook a study using similar types of green feed including lucerne and recorded ovulation rate increases of up to 10% in synchronised ewes. An economic analysis based on the Robertson *et al.* (2013) data indicated that a 10% increase in lambing would produce an extra $48/ha profit. Similar increases in ovulation responses can be achieved with lupins, but generally at a higher cost to the enterprise.

Ovulation rate increases of 18% (Roberston *et al.*2014) and 30% ([A]Robertson *et al.*2015) were recorded in ewes given a short term flush on lucerne pastures compared to ewes grazing on dry feed. Where the short flush resulted in 30% more foetuses per ewe grazing lucerne compared to those on dry pasture, 19% more lambs were also marked per ewe joined. In all the aforementioned research, the short flush consisted of ewes grazing lucerne for one week prior to and for one week after the start of joining.

Additional research conducted by [A]Robertson *et al.* (2015) investigated whether grazing ewes on lucerne for seven days prior to and throughout joining (long flush) would increase foetal numbers compared to a short flush and grazing dry pasture. This was examined as there are some reports of high quality feeds fed during early pregnancy having a negative impact upon embryo survival ([B]Robertson *et al.*2015), leading to a recommendation to remove ewes seven days after the start of joining to maximise ovulation rate yet minimise embryo mortality (Robertson *et al.*2014). The ingestion of coumestans (a type of phytoestrogen) present in lucerne infected with fungus, has also been found to reduce ovulation rate in ewes (Smith *et al.*1979) and it is suggested that this situation can be avoided by not grazing the when it is affected by disease, fungal or insect infestation.

[A]Robertson *et al.* (2015) revealed that there was no advantage or disadvantage in grazing lucerne past day seven of joining as the long flush did not result in additional foetuses per ewe compared to a short flush. There was also no increase in the proportion of non-pregnant ewes or in ewes returning to service when they grazed lucerne compared to dry pasture, indicating no major problems with embryo mortality or fertilisation failure.

Robertson *et al.* (2013) suggested that any green feed could elicit a flushing response and King *et al.* (2010) reported that it could be achieved with as little as 350 kg DM/ha of green feed. The flushing response in the King *et al.*2010 study was attributed to the higher amount of green feed present in the lucerne pasture compared to that in the dry pasture throughout the joining period. Furthermore it was proposed that it was the total amount of green feed rather than the species of pasture that caused the ovulatory response.

The aim of this project undertaken by Agricultural Victoria and co-funded by MLA was to demonstrate and validate the recent research outlined above using grazing management ‘typical’ to a number of commercial farms representing a range of environments and ewe breeds and joining time between late December and March when pasture is generally senescent and therefore of low nutritional value. The effects of short term (graze one week prior to joining and one week into joining) and long term (one week prior to joining and through the entire joining period) flushing with green feed or lucerne compared to typical available dry pasture or dry pasture with lupin supplementation on ewe conception rate (ewes pregnant / ewes joined) and reproduction rates (lambs scanned / 100 ewes) was investigated. The remainder of this report outlines the project objectives, methodology, results, key outcomes and recommendations.

3 Project objectives

1. Validate and demonstrate the impact of grazing lucerne or sources of green feed at joining on ewe reproduction at seven sites per year for two years across southern Australia.
2. Validate and demonstrate the impact of feeding lupins at joining on ewe reproduction at four of the seven sites per year across southern Australia.
3. Validate and demonstrate the impact of grazing lucerne throughout joining on early embryo mortality.

4 Methodology

4.1 Experimental design

There were two phases of investigation undertaken across the life of the project to achieve the project objectives.

Phase 1 (2013-2014)

- Establish seven sites each year for two years, comparing the impact on ewe conception and reproduction rates of grazing green feed (>1000 kg DM/ha of green feed available) at joining for one week prior to joining to one week into joining (Green Feed Short Flush) compared to grazing the typical pasture available. The aim was to run half of these demonstrations with merino ewes and the other half with cross bred/composite ewes, with the flocks being joined between January and April.
- Establish four sites each year for two years, comparing the impact on ewe conception and reproduction rates of using a Green Feed Short Flush compared to feeding 0.3-0.5kg/head/day lupins plus typical dry pasture over the same period, and compared to only grazing the typical pasture available. The aim was to run half of these demonstrations with merino ewes and the other half with cross bred/composite ewes, with the flocks being joined between January and April.

Phase 2 (2015-2017)

- Establish ten sites over three years, comparing the impact on ewe conception and reproduction rates of grazing lucerne at joining for varying periods of time compared to grazing the typical pasture available. The length of grazing on lucerne was either (1) a Lucerne Short Flush: graze one week prior to joining to one week into joining, then graze typical dry pasture until the end of joining, or (2) a Lucerne Long Flush: graze one week prior to joining and through the entire joining period or for a minimum of five weeks. The aim was to run half of these demonstrations with merino ewes and the other half with cross bred/composite ewes, with the flocks being joined between January and April.

A total of 32 sites were established with more than 22,000 ewes joined from 2013 to 2017. An overview of treatments is shown in Table 1.

Table 1. Treatments conducted during Phase 1 and Phase 2 of the project.

Years	Treatments
Phase 1 2013-2014	1. **Control**: graze typical dry pasture available throughout joining 2. **Green Feed Short Flush**: graze green feed one week prior to joining and one week into joining 3. **Control plus Lupins**: graze typical dry pasture available throughout joining plus 0.3-0.5kg/head/day, one week prior to joining and one week into joining
Phase 2 2015-2017	1. **Control**: graze typical dry pasture throughout joining 2. **Lucerne Short Flush**: graze lucerne one week prior to joining and one week into joining 3. **Lucerne Long Flush**: graze lucerne one week prior to joining and throughout the joining period or for a minimum of five weeks

4.2 Site selection

Sites that represented a broad range of environments across Victoria were sought, and where possible sites in New South Wales and South Australia were also established. Commercial producers were reached and engaged through Agriculture Victoria's BestWool/BestLamb network and other industry networks such as Lucerne Australia. Media promotion and personal contact were also used to secure participants.

Management practices typical of each property's normal management were followed at each site, including joining time, length of joining and feed supplementation pre and post joining. This enabled valid comparisons between the Control and treatment groups over a range of different site management practices and environments.

4.3 Animals

The project utilised merino, first cross or composite ewes sourced from the commercial flocks at each site. The project aimed to run merino ewes at half of the sites and cross bred or composite ewes at the remaining sites, however poor seasonal conditions in 2013, 2015 and 2016 made it difficult to obtain the required mix of breeds. Consequently, it was decided to accept more merino sites to ensure that sufficient data for analysis was achieved.

Adult ewes were preferentially utilised in most instances instead of maiden ewes to minimise any factors, such as sexual maturity, influencing conception rate (CR: ewes pregnant/ewes joined) and reproduction rate (RR: lambs scanned per 100 ewes joined). Maiden ewes for example typically tend to have lower multiple births compared to adult ewes. However, three sites included maiden ewes in 2016 to ensure that adequate numbers per treatment were obtained.

Ewes were joined at various sites from late December until March, with the majority joining in February and March. At the start of each demonstration, ewes were randomly allocated to each treatment (n=200-300) and identified with electronic tags for ease of data collection. All ewes were weighed and assessed for body condition score (CS) at the first site visit and then weighed two weeks later at the end of the short flush (Phase 1 and 2) and weighed at the end of joining for Phase

2. Ewes were pregnancy scanned at day 85 to 90 from the start of joining to determine the CR and RR.

Approval was granted by the DEDJTR Animal Ethics committee (Protocol No. 2013-06) prior to the commencement of this study.

4.4 Pastures

The species of dry pasture used in the Control treatments (typical dry pasture) within this study included phalaris, perennial and annual rye grass, a combination of ryegrass and phalaris, clover, wheat or canola stubble and native pastures. In keeping with the typical farm management of an individual site, additional supplementation was provided to the Control treatment at some sites and during some years of poor seasonal conditions. Grain supplementation was fed either as a single source or a mixed ration and included barley, triticale and oats. Several sites also fed pasture hay to the Control group.

Green feed sources used in Phase 1 (2013-2014) of the study included lucerne (irrigated and dry), irrigated millet, rape and green perennial pasture (refer Table 3) while only irrigated and or dryland lucerne was used as the green feed source during Phase 2 (2015-2017).

The nutritive value of pastures, supplements and green paddock feed on offer used in the varying treatments throughout the demonstration were generally tested at the start of the demonstration period, at the end of the short flush, and again at the end of the long flush at all sites. For various reasons, e.g. food on offer had depleted too low to sample or supplement quality results were not available from the producer, not all Control, Green Feed Short Flush, Lucerne Short Flush and Lucerne Long Flush treatments were sampled at each site visit.

4.5 Management protocol for Phase 1 and 2

The following management steps were followed to achieve each objective across the life of the project.

Visit 1: Start of treatment site visit (1 week prior to joining)

- Individually identify all ewes with electronic ear tags
- Weigh and condition score all demonstration ewes (Wt 1)
- Inspect and record current paddock and supplementation rations
- Inspect treatment and Control paddocks to be used from -1 week to +1 week of joining
- Randomly split demonstration ewes into treatment groups – 200-300 ewes per treatment
- Assess treatment and Control paddocks to quantify kg DM/ha, record current paddock and supplementation rations, undertake feed testing to quantify feed quality of pasture and any supplements, record a series of photos
- Verify joining protocol with landholder, to commence in one week, including using at least 1.5-2% rams at joining

Visit 2: End of treatment site visit (1 week into joining)

- Weigh all demonstration ewes (Wt 2)

- Remove short flush ewes from lucerne or other green feed and combine Control and short flush treatment groups back into one mob
- Assess treatment and Control paddocks to quantify kg DM/ha, record current paddock and supplementation rations, undertake feed testing to quantify feed quality of pasture and any supplements, record a series of photos
- Verify protocol with landholder for the end of joining and pregnancy scanning

Visit 3: End of joining site visit (Phase 2 only)

- Weigh all demonstration ewes (Wt 3)
- Assess treatment and Control paddocks to quantify kg DM/ha, record current paddock and supplementation rations, undertake feed testing to quantify feed quality of pasture and any supplements, record a series of photos

Pregnancy scanning site visit (day 85 to 90 from the start of joining)

- Pregnancy scan all demonstration ewes and ensure accuracy of data recording.

4.6 Method changes in Phase 2

In Phase 1 of the project, ewes in the Green Feed Short Flush treatments were joined on a range of green feed sources. In 2015-2017 the project team moved to use lucerne only as the green feed source. Lucerne is typically the preferred feed grazed by producers when joining ewes, therefore results that reflect the outcomes from joining on lucerne were deemed more relevant to the sheep industry.

In Phase 1 a total of 600 ewes per site was required for the Green Feed Short Flush and Control treatments. Phase 2 incorporated an additional Lucerne Long Flush treatment, necessitating the use of 900 ewes per site in 2015 to 2017. Due to a limited number of available ewes per site, the requirement to increase the number of ewes for Phase 2 was problematic for some producers. In consultation with the project's biometrician and MLA, the mob size per treatment was reduced to a minimum of 200, which still enabled data integrity to be maintained.

At two sites it was not possible to include a Control treatment due to the limited number of ewes available.

At a third site the co-operator did not include a Control treatment due to previous involvement in the project. This producer's reluctance to run merino ewes on typical dry pasture (Control treatment) was due to the positive reproductive results previously attained by joining on green feed. Treatments at this site were confined to a comparison of the Lucerne Short Flush and the Lucerne Long Flush, after consultation with the biometrician and MLA, it was considered appropriate to compare just the flushing treatments for this site.

4.7 Seasonal conditions

Poor seasonal conditions in 2013, 2015 and 2016 impacted on the ability to deliver the project's yearly objectives. The project methodology was adjusted in consultation with MLA to ensure that the objectives could still be met. Table 2 outlines the strategies put in place when poor seasonal conditions were encountered.

Table 2. Seasonal conditions encountered and sites established throughout the demonstration 2013-2017.

Year	No of sites established and seasonal condition encountered
2013	7 sites established in Phase 1 Sites were difficult to establish due to the poor 2013 seasonal conditions. An abnormally dry spring and summer created difficulty in accessing sufficient green feed for the planned ten sites as producers had already used their available green feed or allocated it to finish lambs and had no regrowth to allocate to the ewe flock. Therefore, only seven sites of the planned 11 were established.
2014	15 sites established in Phase 1 7 extra sites established in 2014 to counter the lower number of sites established in 2013 due to poor seasonal conditions.
2015	3 sites established in Phase 2 Only three of the planned six demonstration sites were established due to the dry seasonal conditions. All three sites had participated in 2014 and one site used the same merino ewes in 2014 and 2015.
2016	4 sites established in Phase 2 In late 2015 the majority of Victoria had experienced extreme dry seasonal conditions resulting in producers buying in water, setting up stock containment areas and utilising higher quantities of supplementary feed than normally fed during the 2016 joining period. Due to poor seasonal conditions resulting in negligible dry pasture, ewes in Control treatments at three sites were fed a fully supplemented grain or pellet ration, whereas in previous years ewes in the project were fed on dry pasture with some supplementation. Once the two week Lucerne Short Flush treatment was completed, these ewes were fed in containment with the Control ewes. Due to the 'failed' spring seasons of 2014 and 2015, an extension to the project was granted to procure a further five sites in 2017.
2017	3 sites established in Phase 2

A total of 32 sites were established from a planned 34 during the course of the project from 2013 to 2017. The number of sites established and animals per treatment were deemed sufficient to conduct a robust statistical analysis (Gavin Kearny, biometrician – personal communication, 25 July 2017).

4.8 Statistical analysis

An analysis of variance (ANOVA) was used to determine the effects of treatment across all ewe live weights and condition scores with adjustment for ewe class (adult or maiden). Conception rate (ewes pregnant/ewes joined) was assessed by fitting a generalised linear model with binomial distribution and logit link function with fitted effects of treatment, ewe class (adult or maiden), where appropriate, and initial live weight or condition score along with interactions thereof. For all analyses there were no significant interactions present and so these were removed. Also for all main effects only terms that were significant at the 5% level remained in the model except for treatment which was always present.

Reproductive rate was analysed using a General Linear Model with a multinomial distribution and logit link function with fitted effects of treatment, ewe class (adult or maiden), were appropriate and initial liveweight or condition score along with interactions thereof. For all analyses there were no significant interactions present and so these were removed. Also for all main effects only terms that were significant at the 5% level remained in the model except for treatment which was always present.

All statistical analyses were performed using GENSTAT 17th edition (VSN International Ltd, Hemel, Hempstead, UK).

5 Results

5.1 Sites and locality

A total of 32 sites (Fig. 1) were established across a range of different environments in Victoria (n=28), New South Wales (n=3) and South Australia (n=1). Some participants partook in the demonstration over two years and in one instance for three years.

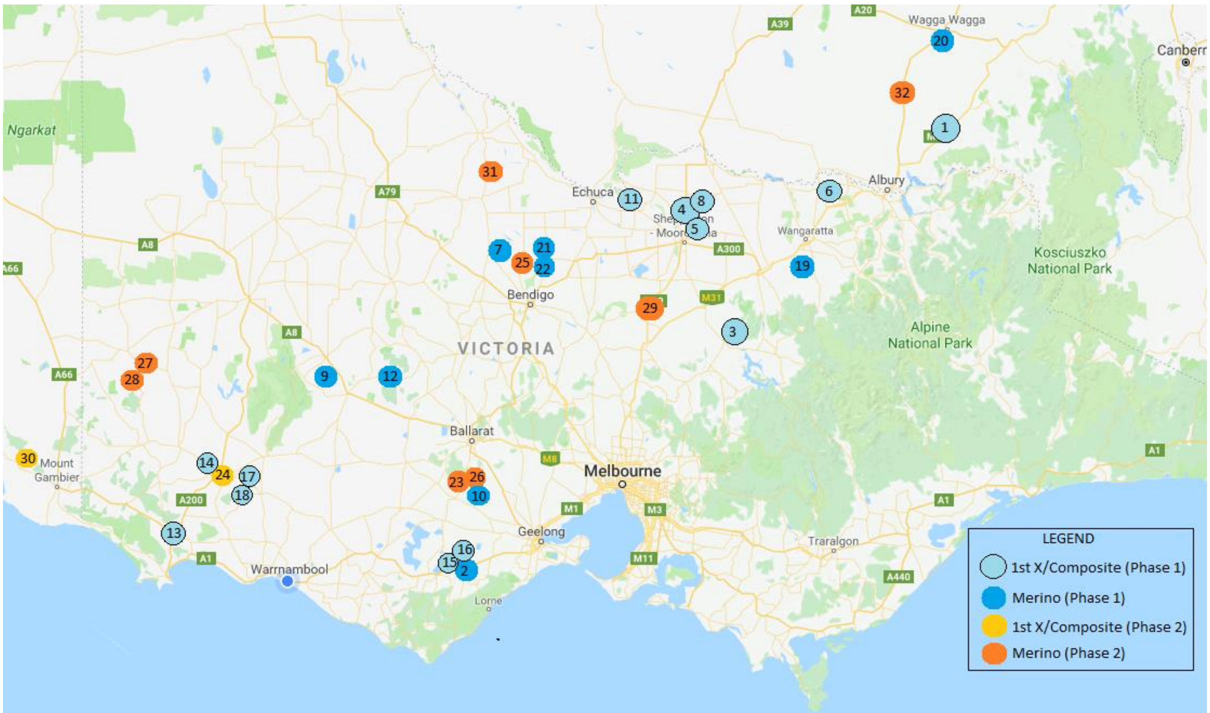

Fig. 1. Location of sites established in Phase 1 and 2 and ewe breed.

Over 22,000 merino, composite and first cross ewes were part of this project from 2013 to 2017. Table 3 outlines the number of sites and breed type per treatment across Phase 1 and 2 of the project.

Table 3. Ewe breeds used each year across each treatment from 2013-2017

Year	Treatment	Ewe breed			Total sites per ewe breed
		Merino	First Cross	Composite	
Phase 1 2013-2014	Control	8 sites †	6 sites	5 sites †	19 sites
	Green Feed Short Flush	9 sites	6 sites	7 sites	22 sites
	Control Plus Lupins	3 sites	4 sites	1 site	8 sites
Phase 2 2015-2017	Control	5 sites †	1 site	1 site	8 sites
	Lucerne Short Flush	8 sites	1 site	1 site	10 sites
	Lucerne Long flush	8 sites	1 site	1 site	10 sites

†At three properties in Phase 1 and one property in Phase 2 the same ewes were used in the Control treatment for two sites. In Phase 2, two sites did not run a Control group due to limited ewe numbers

Ewe joining times

Joining time ranged from late December to the end of March, with the majority of sites joining their ewes in February and March. Reproduction and conception rates were observed to be generally good across all sites, most likely due to sites joining ewes within their natural breeding season.

5.2 Pastures

Site visits to assess pasture and weigh ewes in each treatment were conducted at the start of the demonstration period (Wt1) and at the conclusion of the short flush during Phase 1 and 2 (Wt2), and once joining was completed for Phase 2 (Wt3).

At each visit, pasture cuts were taken of each treatment and where a supplement was fed, a sample was also taken to quantify feed quality. Pasture species, paddock identification and paddock condition were recorded. Treatments were visually assessed for feed on offer (kg DM/ha) and a series of photos taken to provide a pictorial record.

Phase 1 (2013-2014) sources of green feed included lucerne (irrigated and dry), irrigated millet, rape and green perennial pasture (refer Table 4). Figures 2 and 3 are some of the pastures grazed during 2014.

Fig. 2. Control Plus Lupins paddock at Site 10 (Mt Mercer, Vic) in 2014 at the start (left) and end (right) of the demonstration.

Fig. 3. Rape paddock (left) at Site 18 (Tabor, Vic) in 2014 and lucerne paddock (right) at Site 10 (Mt Mercer, Vic) at the end of the short flush.

Phase 2 (2015-2017) sources of green feed were restricted to irrigated and dryland lucerne.

During 2015, seasonal conditions in SW Victoria improved just prior to joining time, resulting in some green feed in the dry Control paddocks (Fig. 4). The resulting impact on ewe condition was evident at the second and final weighing. The presence of green feed in the dry feed treatments may have influenced RR and CR.

Fig. 4. Typical dry pastures (Control treatment) provided to the ewes at the start (left), seven days after joining (middle) and at the end of joining (right) on Site 23 (Mt Mercer, Vic).

At Sites 26 (Mt Mercer, VIC) and 27 (Harrow, Vic) in 2016, the long and short flush ewes were joined on dryland lucerne while the Control treatments were placed into a stock containment area and supplemented with grain due to the extremely dry seasonal conditions (Fig. 5 and 6).

Fig. 5. Control treatment ewes in the stock containment area (left) and lucerne paddock (right) used for short and long flush on Site 26 (Mt Mercer, Vic) at the start of the demonstration.

Fig. 6. Lucerne used for short and long flush on site 27 (Harrow, Vic) at the start (left) and end of joining (right).

At Site 31 (Loddon Vale, VIC) in 2017, the long and short flush ewes were joined on dryland lucerne and the long flush ewes moved to irrigated lucerne at the end of the short flush, while the Control treatment was native pasture. No additional supplementation was provided on either the lucerne or native pasture treatments (Fig. 7).

Fig. 7. Native pasture in the Control treatment (left) and irrigated lucerne paddock (right) used for short and long flush on Site 31, (Loddon Vale, Vic) at the start of the demonstration.

Fig. 8 shows the lucerne paddock at Site 32, (Culcairn, NSW) in 2017, which was used for the both the short and long flush ewes, at start of the demonstration and at the end of joining when the long flush ewes were removed.

Fig. 8. Lucerne at start of the demonstration (left) and lucerne at end of joining (right) on Site 32 (Culcairn, NSW).

5.3 Phase 1 (2013-2014)

5.3.1 Sites and treatments established

In 2013 and 2014, 22 sites were established with in excess of 15,000 ewes joined. Nine sites ran merino ewes and 13 sites had first cross or composite ewes.

The treatments undertaken were:

1. Control: Control group graze typical dry pasture throughout joining
2. Green Feed Short Flush: graze green feed one week prior to joining and one week into joining
3. Control Plus Lupins: 300-500g/hd/day as a supplement from one week prior to joining until one week into joining

Details of the 22 sites managed in 2013 and 2014, the treatments imposed and breeds utilised are presented in Table 4.

Three of the cooperating Phase 1 producers agreed to have two sites each on their properties (Sites 15 and 16 at Irrewarra, Sites 17 and 18 at Tabor, and Sites 21 and 22 at Raywood). At these properties, each pair of sites shared a Control group of ewes due to the available number of ewes. This arrangement was made, in consultation with the project biometrician.

Green feed sources included lucerne (irrigated and dry), irrigated millet, rape and green perennial pasture. Three sites incorporated two separate green feed short flush ewe groups into their demonstration for comparison with one Control treatment on dry feed.

Table 4. Phase 1 (2013 and 2014) sites - location, ewe breed, joining date, ewe number per treatments and species of green feed used in the Green Feed Short Flush treatment.

Site No.	Location	Breed	Join date	Ewe No. per treatment		
				Control	Green Feed Short Flush (with feed type)	Control Plus Lupins
2013						
1	Holbrook, NSW	1st X	13/2/13	300	300 Lucerne	300
2	Birregurra, Vic	Merino	20/3/13	300	300 Lucerne	300
3	Ancona, Vic	1st X	14/1/13	300	300 Phalaris	300
4	Tallygaroopna, Vic	1st X	14/3/13	300	300 Irrigated Millet	300
5	Congupna, Vic	1st X	20/2/13	300	300 Irrigated Lucerne	
6	Rutherglen, Vic	1st X	8/3/13	300	300 Irrigated Lucerne	
7	Serpentine, Vic	Merino	20/2/13	300	300 Dryland Lucerne	
2014						
8	Tallygaroopna, Vic	1st X	19/2/14	381	309 Irrigated Millet	321
9	Rhymney, Vic	Merino	14/2/14	300	300 Dryland Lucerne	300
10	Mt Mercer, Vic	Merino	22/3/14	299	292 Dryland Lucerne	316
11	Kotupna, Vic	Composite	7/3/14	296	300 Irrigated Millet	299
12	Elmhurst, Vic	Merino	12/2/14	300	300 Dryland Lucerne	
13	Heywood, Vic	Composite	31/3/14	300	300 Green perennial pasture on creek flat	
14	Hamilton, Vic	Composite	5/3/14	295	287 Dryland Lucerne	
15	Irrewarra, Vic	Composite	19/2/14	407 †	300 Rape / Millet	
16	Irrewarra, Vic	Composite	19/2/14	407 †	300 Rape / Lucerne	
17	Tabor, Vic	Composite	13/2/14	300 †	317 Dryland Lucerne	
18	Tabor, Vic	Composite	13/2/13	300 †	317 Rape	
19	Greta, Vic	Merino	15/2/14	200	195 Dryland Lucerne	
20	Wagga Wagga, NSW	Merino	7/3/14	100	100 Dryland Lucerne	

Site No.	Location	Breed	Join date	Ewe No. per treatment		
				Control	Green Feed Short Flush (with feed type)	Control Plus Lupins
21	Raywood, Vic	Merino	18/2/14	293 †	418 Dryland Lucerne	
22	Raywood, Vic	Merino	18/2/14	293 †	293 Dryland Lucerne	

† The Control treatment was the same at Sites 15 & 16, 17 & 18, 21 & 22 (experimental structure took account of this)

5.3.2 Live weight and Condition score

The range of initial liveweights at the start of the demonstration period at each site ranged from 47.5kg to 72.5kg in 2013 and 49.5kg to 69.6kg in 2014 (Table 5). Ewe condition scores ranged from 2.5 to 3.3 in 2013 and 2.8 to 3.7 in 2014.

Table 5. 2013 and 2014 average initial liveweight (kg) and condition score (CS) of ewes at the start day of allocation to a treatment at each site.

Site No	Average initial liveweight (kg)	Average Condition Score (Low 1- High 5)
2013		
1	47.8	2.5
2	55.3	2.9
3	72.5	3.3
4	61.8	3.1
5	60.7	3.0
6	61.0	3.0
7	72.2	Iı
2014		
8	67.2	3.2
9	61.4	3.1
10	49.5	3.3
11	69.6	3.1
12	48.6	3.0
13	55.3	3.7
14	57.0	3.7
15 & 16	57.4	3.4
17 & 18	65.3	3.0
19	57.8	3.1
20	54.0	2.8
21 & 22	65.5	3.2

ıı Data not recorded for this site

In 2013, six (1, 2, 3, 4, 5, 7) of the seven sites there were significantly greater liveweight gains in ewes on the Green Feed Short Flush compared to the Control. Ewes in the Control Plus Lupins treatment also showed a greater increase in liveweight on all four sites (1, 2, 3, 4) compared to those in the Control treatment.

At two sites (2, 3) the liveweight gain was greater for the Control Plus Lupins treatment than for the Green Feed Short Flush treatment, whereas at the other two sites (1, 4) the liveweight gain was greater for the Green Feed Short Flush than for the Control Plus Lupins treatment (Table 6).

Table 6. 2013 site data. Average liveweight change (kg/hd) over treatment period

Site No	Average liveweight change (kg)			
	Treatment			
	Control	Green Feed Short Flush (with feed type)	Control Plus Lupins	Significance*
1	0.7 c	7.6 (Lucerne) a	2.3 b	P<0.001
2	-2.3 c	-0.1 (Lucerne) b	1.9 a	P<0.001
3	-1.7 c	-0.4 (Pasture) b	2.2 a	P<0.001
4	-0.4 c	3.4 (Millet) a	2.3 b	P<0.001
5	-1.3 b	0.5 (Lucerne) a		P<0.001
6	2.7 a	2.4 (Lucerne) a		NS
7	-5.0 b	-3.9 (Lucerne) a		P<0.001

* Within a given row for predicted liveweight change, means followed by the same letter a, b or c are not significantly different (P>0.05) NS – Treatment effect is not significant (P>0.05)

In 2014, eight (8, 9, 11, 12, 13, 14, 19, 20) of the 15 Green Feed Short Flush sites recorded a significantly greater liveweight gain than the Control treatment (Table 7). Whereas six (10, 15, 16, 17, 18, 21) Green Feed Short Flush sites recorded a significantly lower liveweight gain (or greater liveweight loss) than the Control treatment. One site (22) showed no significant difference in liveweight change.

Ewes in three of the Control Plus Lupins sites (8, 9, 11) recorded a significantly greater liveweight gain than the Control treatment.

The liveweight gain for the Control Plus Lupins treatment was significantly greater than for the Green Feed Short Flush treatment at one site (11), significantly less at two sites (8, 10) and not significantly different at one site (9).

The liveweight change trends due to the supplementation of lupins on dry feed are similar to the 2013 data, with a total of seven out of eight sites in 2013-14 showing a significantly greater liveweight increase for the Control Plus Lupins treatment compared to the Control.

Table 7. 2014 site data. Average liveweight change (kg/hd) over treatment period

Site No	Average liveweight change (kg)			
	Treatment			
	Control	Green Feed Short Flush (with feed type)	Control Plus Lupins	Significance*
8	-1.8 c	3.2 (Millet) a	0.2 b	P<0.001
9	-0.7 b	0.9 (Lucerne) a	1.4 a	P<0.001
10	0.3 a	-0.7 (Lucerne) b	-1.2 c	P<0.001
11	4.0 c	5.6 (Millet) b	6.5 a	P<0.001
12	1.4 b	3.0 (Lucerne) a		P<0.001
13	-0.8 b	2.6 (Pasture) a		P<0.001
14	4.5 b	5.3 (Lucerne) a		P<0.001
15&16	-0.3† a	-1.1 (Pasture) b -1.2 (Pasture) b		P<0.001 P<0.001
17&18	2.9† a	1.4 (Lucerne) b -1.4 (Rape) c		P<0.001 P<0.001
19	5.1 b	6.9 (Lucerne) a		P<0.001
20	-3.5 b	1.4 (Lucerne) a		P<0.001
21&22	3.3† a	2.5 (Lucerne) b 3.8 (Lucerne) a		P<0.001 NS

* Within a given row for predicted liveweight change, means followed by the same letter a, b or c are not significantly different (P>0.05) NS – Treatment effect is not significant (P>0.05)

† The Control treatment was the same for both sites (experimental structure took account of this)

5.3.3 Impact of feed type on reproductive rate (RR)

Analysis of the 2013 and 2014 data shows a positive reproductive rate (lambs scanned per 100 ewes joined) response to the Green Feed Short Flush over the Control treatment for 13 of the 22 sites (Table 8) that is not related to initial liveweight or condition score (i.e. there was no interaction of treatment with either).

In 2013, five (1, 2, 4, 5, 6) out of seven Green Feed Short Flush sites showed a significant increase in RR compared to the Control treatment. The increase in RR across these sites ranged from 12 to 30 lambs scanned per 100 ewes joined. In 2014, eight (8, 9, 10, 12, 14, 15, 16, 20) out of 15 sites Green Feed Short Flush sites showed a significant increase in RR compared to the Control treatment. The increase in RR ranged from 10 to 33 lambs scanned per 100 ewes joined, compared to the Control treatment.

It should be noted that, at site 13, although not statistically different, the RR was slightly higher for Control compared to the Green Feed Short Flush. This was not a surprising outcome for this site as there was rain just prior to commencement of the demonstration and clover was observed at the first assessment in the Control paddock which therefore provided higher quality green feed than dry feed alone.

In 2013 and 2014, five (2, 4, 8, 9, 11) out of the eight Control Plus Lupins sites showed a significant increase in RR compared to the Control treatment. The increase in RR across these sites ranged from 8 to 21 lambs scanned per 100 ewes joined.

At five (2, 3, 4, 8, 11) of the eight Control Plus Lupins sites, there was no significant difference in RR between the ewes in the Control Plus Lupins and the Green Feed Short Flush treatments.

Two sites (1, 10) however measured a lower RR on Control Plus Lupins (20 and 12 fewer lambs scanned per 100 ewes joined respectively) compared to the Green Feed Short Flush but these results were not significantly different to the Control. One Control Plus Lupins site (9) measured a lower RR (19 fewer lambs scanned per 100 ewes joined) compared to ewes on a Green Feed Short Flush but also 14 lambs scanned per 100 ewes joined greater than the Control.

Overall the RR of ewes given a Green Feed Short Flush treatment exceeded the response to Control Plus Lupins yet only three (1, 9, 10) from the eight sites recorded significant RR gains.

Table 8. Average reproductive rate (lambs scanned / 100 ewes joined) for each site in 2013 & 2014.

Site No	Average reproductive rate (lambs scanned / 100 ewes joined)			
	Treatment			
	Control	Green Feed Short Flush (with feed type)	Control Plus Lupins	Significance*
2013				
1	125 b	151 (Lucerne) a	131 b	P<0.001
2	102 b	132 (Lucerne) a	123 a	P<0.001
3	170 a	173 (Pasture) a	180 a	NS
4	165 b	180 (Millet) a	177 a	P<0.05
5	172 b	184 (Lucerne) a		P<0.05
6	155 b	180 (Lucerne) a		P<0.001
7	140 a	142. (Lucerne) a		NS
2014				
8	147 b	159 (Millet) a	155 a	P<0.001
9	98 c	131 (Lucerne) a	112 b	P<0.001
10	126 b	141 (Lucerne) a	129 b	P<0.01
11	151 b	154 (Millet) ab	161 a	P<0.05
12	106 b	118 (Lucerne) a		P<0.01
13	158 a	153 (Pasture) a		NS
14	152 b	162 (Lucerne) a		P<0.05
15&16	125† b	147 (Pasture) a 145 (Pasture) a		P<0.001
17&18	155† a	159 (Lucerne) a 155 (Rape) a		NS
19	146 a	147 (Lucerne) a		NS
20	131 b	157 (Lucerne) a		P<0.01
21&22	137† a	143 (Lucerne) a 146 (Lucerne) a		NS

* Within a given row for predicted reproductive rate, means followed by the same letter a, b or c are not significantly different (P>0.05) NS – Treatment effect is not significant (P>0.05)

† The Control treatment was the same for both sites (experimental structure took account of this)

5.3.4 Impact of feed type on conception rate (CR)

Analysis of the 2014 conception rate (ewes pregnant per ewes joined) data shows three (9, 12, 21) of the 15 Green Feed Short Flush treatment sites had a significant increase in CR of 4, 7 and 13 pregnancies per 100 ewes joined compared to the Control treatment (Table 9). These three sites all utilised lucerne as the green feed source.

Across the four sites that also included a Control Plus Lupin treatment, one site (9) showed a significantly higher CR for the Green Feed Short Flush treatment compared to Control Plus Lupins treatment. None of the Control Plus Lupins treatments produced a significant increase in CR over the control treatments.

Table 9. Average conception rate (ewes pregnant per ewes joined) for each 2014 site.

Site No	Average conception rate (ewes pregnant / ewes joined)			
	Treatment			
	Control	Green Feed Short Flush (with feed type)	Control Plus Lupins	Significance*
9	78 b	91 (Lucerne) a	82 b	P<0.001
12	91 b	95 (Lucerne) a		P<0.05
21&22	87† b	94 (Lucerne) a 90 (Lucerne) b		P<0.05
8	95 a	98 (Millet) a	97 a	NS
10	92 a	95 (Lucerne) a	93 a	NS
11	97 a	98 (Millet) a	96 a	NS
13	97 a	98 (Pasture) a		NS
14	97 a	99 (Lucerne) a		NS
15&16	92† a	92 (Pasture) a 95 (Pasture) a		NS
17&18	94† a	94 (Lucerne) a 96 (Rape) a		NS
19	94 a	98 (Lucerne) a		NS
20	88 a	91 (Lucerne) a		NS

* Within a given row for predicted conception rate, means followed by the same letter a, b or c are not significantly different (P>0.05) NS – Treatment effect is not significant (P>0.05)

† The Control treatment was the same for both sites (experimental structure took account of this)

The results show that providing a short flush on green feed for two weeks, one week prior to joinig and removing ewes from the green feed source one week post joining provides benefits to ewe fertility. Improved fertility occurred due to an increase in RR and to a lesser extent an increase in CR, for the majority of the Green Feed Short Flush and Control Plus Lupins treatments compared to the Control treatment.

5.3.5 Feed test analysis

The nutritive value of the pastures and grain fed to ewes throughout the 2014 demonstration year was assessed. An overview is provided in Table 10. The project aimed to sample twice, once at the start of the demonstration period and again at the end of the short flush, seven days after joining. Visual assessment of Control or Green Feed Short Flush pastures were undertaken at each site visit to estimate feed on offer, species present and the condition of each treatment. All treatments, taking into account planned supplementation were assessed as having adequate feed availability to sustain ewes for two weeks during the demonstration period. There were no incidences of poor quality due to foliar disease, fungus or insect infestation observed on any of the Control or Green Feed Short Flush treatments.

The average metabolisable energy, protein, and water soluble carbohydrate values of the Control treatments (typical dry pasture) were fairly low compared to the sampled Green Feed Short Flush treatments which were relatively high throughout joining. The average nutritive values are presented along with the range as some sites received rain during the demonstration period resulting in green feed in the Control treatments at the end of the short flush which in turn led to a higher ME and protein being recorded for some sites. Refer to Table A1 in Appendix 10.1 for individual site feed tests results.

Table 10. Average and range of metabolisable energy (MJ ME/kg DM), crude protein (CP%), neutral detergent fibre (NDF%) and water soluble carbohydrate (WSC%) of the Control (typical dry pasture available) Green Feed Short Flush and Control plus Lupins treatments based on a combination of samples taken 7 days prior to joining (Wt1) and 7 days after joining (Wt2).

Feed test analysis	Treatment in 2014					
	Control		Green Feed Short Flush		Control Plus Lupins	
	Average	Range	Average	Range	Pasture average	Pasture range
Average of ME	6.4	3.0-7.8	10.5	7.5-12.1	6.0	5.3-6.0
Average of CP	8.2	3.3-13.3	17.7	13.4-25.4	7.2	3.5-10.2
Average of NDF	73.9	71.0-79.5	46.6	36.0-65.2	73.5	72.0-78.3
Average of WSC	5.6	4.0-8.4	7.4	4.6-8.9	5.2	4.7-5.8

The Control plus Lupin treatments were on sites 8, 9, 10 and 11 and ewes were fed between 0.3-0.5 kg/hd/day during the demonstration period. Table 11 outlines the nutritive values of the lupins used in the Control Plus Lupins treatments. Other grains such as barley, triticale, oats or wheat which were used to supplement the Control ewes at sites 10, 11, 17, 18, 21 and 22 due to low available pasture prior to and during the demonstration period.

Table 11. Average metabolisable energy (MJ ME/kg DM), crude protein (CP%), neutral detergent fibre (NDF%) and water soluble carbohydrate (WSC%) of grain samples tested at sites 10,11,17,18, 21 and 22.

Feed test analysis	Grain				
	Lupins	Barley	Oats	Triticale	Wheat
Average of ME	85.4	83.3	74.15	80.4	86.2
Average of CP	14	12.9	12.45	12.5	13.3
Average of NDF	28.7	10.2	10.4	9.7	10.9
Average of WSC	12.4	7.6	13.55	6	5.5

Although not analysed, it appears there was no apparent relationship shown between feed quality and the response in reproduction efficiency within this project.

5.4 Phase 2 (2015-2017)

5.4.1 Sites and treatments established

In 2015, 2016 and 2017 ten sites were established with in excess of 7500 joined ewes. Eight sites ran merino ewes while one site had composite ewes and a further site had first cross ewes (Table 12).

For this phase a Lucerne Long Flush treatment was included in response to industry feedback of lower reproduction being observed by some producers when ewes grazed lucerne throughout joining. All 10 sites joined ewes for a duration of 5-6 weeks.

The treatments undertaken were:

1. Control: Control group graze typical dry pasture throughout joining
2. Lucerne Short Flush: graze lucerne one week prior to joining and one week into joining
3. Lucerne Long Flush: grazing the lucerne source through the joining period for or a minimum of 5 weeks

Table 12. 2015-2017 sites established location, ewe breed and number per treatments.

Site No	Location	Breed	Join Date	Ewe No. per treatment		
				Control	Green Feed Short Flush (with feed type)	Control Plus Lupins
2015						
23#	Mt Mercer, Vic	Merino	4/3/15	255	251	257
24#	Hamilton, Vic	Composite	2/3/15	240	230	230
25#	Raywood, Vic	Merino	20/2/15	§	257	235
2016						
26‡	Mt Mercer, Vic	Merino (*25% maiden)	3/3/16	247	227	240
27‡	Harrow, Vic	Merino (*68% maiden)	18/3/16	342†	345	339
28‡	Harrow, Vic	Merino (*68% maiden)	18/3/16	†	343	332
29	Nagambie, Vic	Merino	16/2/16	§	270	263
2017						
30	Millicent, SA	1st X	20/12/16	246	251	248
31	Loddon Vale, Vic	Merino	1/2/17	405	317	310
32	Culcairn, NSW	Merino	16/2/17	415	294	291

† The same ewes were in the Control treatment used at both sites

‡ Maiden ewes were included in the treatments. In previous years all ewes were mature

§ Compared short and long flush only due to limited number of ewes available

All sites participated in 2014

At all sites the Lucerne Short Flush and Lucerne Long Flush treatments grazed lucerne as one mob from one week prior to joining (Wt 1) until 1 week after joining (Wt 2). The Lucerne Short Flush ewes were then removed from the mob at the second weighing and either combined with the Control treatment group or grazed dry feed similar to the Control group until the end of joining. Feeding regimes varied at each site as the aim of the demonstration was to compare each site's typical grazing management on dry feed with a Short and Long Flush while grazing lucerne.

In 2015-2017 eight of the ten sites joined ewes on lucerne for five weeks while two other sites (23, 26) joined for six weeks. Ewes on sites 23, 26 and 29 remained on lucerne after the rams were removed and until pregnancy scanning, whereas the ewes on the other sites were removed from the lucerne after joining was completed.

During the 2016 joining season the majority of Victoria experienced extreme dry seasonal conditions resulting in producers buying in water, setting up stock containment areas and utilising higher quantities of supplementary feed than normally fed at this time of year. Due to poor seasonal conditions resulting in negligible dry pasture, ewes in Control treatments at sites 26, 27 and 28 were fed a fully supplemented grain or pellet ration, whereas in previous years ewes in the project were fed on dry pasture, with some supplementation. Once the two week Lucerne Short Flush treatment was completed, these ewes were moved into a stock containment area and fed with the Control ewes.

In 2017 at site 30, all ewes were supplemented on barley prior to joining. The Lucerne Short Flush and Lucerne Long Flush treatments commenced grazing on a mixed stand of lucerne with some barley and rye grass, clover and broadleaf weeds, and were then moved to pure lucerne stand after 4-5 days. At site 31, the Lucerne Short and Long Flush ewes were joined on dryland lucerne for two weeks and then the Lucerne Long Flush grazed irrigated lucerne until the end of joining. The Control ewes grazed native pasture. No additional supplementation was provided for the Lucerne Short or Long Flush or the Control treatments. At site 32 the ewes in all treatments were supplemented with 4 kg wheat/head/week prior to and throughout joining. In addition, ewes in the Control treatment were fed 2kg lupins/head/week prior to and throughout joining. The Control group initially grazed wheat stubble, followed by grazing dry annual pasture.

5.4.2 Live weight and Condition score

The range of initial liveweight and ewe condition score at each site from the start of the demonstration period for 2015, 2016 and 2017 are presented in Table 13. Across these years and sites the liveweight varied from 40.5kg to 86.4kg while condition score ranged from 2.8 to 3.2 for all sites apart from CS 4.6 at site 31.

Table 13. 2015, 2016 and 2017 average initial liveweight (kg) and condition score (CS) of ewes at the start day of allocation to a treatment at each site.

Site No	Average initial liveweight (kg)	Average Condition Score (Low 1- High 5)
2015		
23	52.3	3.0
24	57.2	3.2
25	68.9	3.1
2016		
26	49.5	2.9
27	40.5	2.9
28	40.4	2.9
29	50.3	2.8
2017		
30	86.4	4.6
31	62.8	3.1
32	57.0	2.8

In 2015-2017 analysis of the average liveweight change (kg/hd) from the start of the treatment period (Wt1) until the end of the short flush (Wt2) (Table 14) and from Wt2 until the end of joining (Wt3) (Table 15) was undertaken.

Sites 27 and 28 did not measure the 2nd and 3rd live weights and are therefore are not included in the statistical analysis presented. Ewes in the Lucerne Short and Long Flush were run together from the start until the end of the short flush and therefore sites without a Control treatment (25, 29) were removed from liveweight change analysis for Wt1 to Wt2 (Table 14).

In three (24, 30, 32) of the six sites, ewes grazing a Lucerne Short Flush had a significant liveweight increase between the start of the treatment period (Wt1) until the end of the short flush 14 days later (Wt2) compared to the Control. In a further three (23, 26, 31) sites the average liveweight did not change significantly between Wt1 and Wt2.

Table 15. 2015-2017 site data. Average liveweight change (kg/hd) from the start of the treatment period until the end of the short flush for each treatment.

Site No	Average liveweight change (kg) from Wt1 until Wt2			
	Treatment			
	Control	Lucerne Short flush	Lucerne Long flush	Significance*
2015				
23	1.31 a	1.01 a	1.23 a	NS
24	3.60 b	4.42 a	4.04 ab	P<0.05
2016				
26‡	1.16 b	0.89 b	2.48 a	P<0.001
2017				
30	-0.24 b	1.73 a	1.66 a	P<0.001
31	-0.77 a	-0.66 a	-0.57 a	NS
32	0.62 b	5.76 a	5.52 a	P<0.001

* Within a given row for predicted liveweight change, means followed by the same letter a, b or c are not significantly different (P>0.05) NS – Treatment effect is not significant (P>0.05)
‡ Maiden ewes were included in the treatments. In previous years all ewes were mature ewes.

In 2015 the average liveweight on three (23, 24, 25) sites did not change significantly between Wt2 (liveweight recorded one week after joining) and Wt3 (liveweight recorded at the end of the Lucerne Long Flush). In 2016-2017 ewes on three (26, 30, 32) sites showed a significant weight gain on the Lucerne Long Flush compared to the Control treatment (Table 16).

Ewes at four (26, 29, 30, 32) of the eight Lucerne Long Flush treatment sites had a significant liveweight gain compared to the ewes provided a Lucerne Short Flush. At site 31 however the ewes lost weight on the Lucerne Long Flush treatment compared to those on the Lucerne Short Flush.

Table 16. 2015-2017 site data. Average liveweight change (kg/hd) from the second weight 7 days after joining until the end of joining (i.e. long flush).

Site No	Average liveweight change (kg) from Wt2 until Wt3			
	Treatment			
	Control	Lucerne Short flush	Lucerne Long flush	Significance*
2015				
23	1.55 a	1.54 a	1.34 a	NS
24	-4.76 a	-5.12 a	-4.73 a	NS
25	§	0.84 a	0.23 a	NS
2016				
26‡	-8.18 b	-7.44 b	-1.79 a	P<0.001
29	§	1.29 b	2.21 a	P<0.001
2017				
30	1.18 b	0.15 c	6.32 a	P<0.001
31	1.34 b	2.58 a	1.13 b	P<0.001
32	-1.68 b	-1.17 b	3.75 a	P<0.001

* Within a given row for predicted liveweight change, means followed by the same letter a, b or c are not significantly different (P>0.05) NS – Treatment effect is not significant (P>0.05)

‡ Maiden ewes were included in the treatments. In previous years all ewes were mature

§ Compared short and long flush only due to limited number of ewes available

5.4.3 Impact of feed and duration of flushing on reproductive rate (RR)

Impact of flushing on RR

Analysis of the 2015-2017 RR data (Table 17) shows a significant increase in RR of 12 to 24 lambs scanned per 100 ewes joined at three (23, 27, 28) of the eight Lucerne Short Flush sites which included a Control treatment regardless of initial liveweight or condition score effect (no significant interaction of treatment was present with either liveweight or condition score), compared to the Control treatment. The RR was not significantly different at the remaining four (24, 26, 30, 32) Lucerne Short Flush sites compared to the Control treatment.

Two sites (27, 28) showed a higher RR for both the Lucerne Short Flush (22 and 24 more lambs scanned per 100 ewes joined) and Lucerne Long Flush (39 and 47 more lambs scanned per 100 ewes joined) treatments compared to the Control. Site (23) showed a higher RR (12 more lambs scanned per 100 ewes joined) for the Lucerne Short Flush over the Control, however the Lucerne Short Flush was not significantly different to the Lucerne Long Flush.

A differing result was recorded for site 31 whereby a significant RR increase (16 more lambs scanned per 100 ewes joined) was found in the Control treatment compared to those in the Lucerne Short Flush.

Impact of Lucerne Long Flush on RR

A significant increase in RR ranging from 16 to 47 more lambs scanned per 100 ewes joined, was recorded at three (27, 28, 32) Lucerne Long Flush sites compared to the Control treatment. There was no significant RR difference between the Lucerne Long Flush and Control treatment at the remaining five (23, 24, 26, 30, 31) sites that included a Control treatment.

In three (26,27,28) Lucerne Long Flush sites there is a significant increase in RR ranging from 17 to 23 more lambs scanned per 100 ewes joined compared to the Lucerne Short Flush treatment. On the remaining seven sites (23, 24, 25, 29, 30, 31) there was no significant difference in RR between grazing ewes on a Lucerne Short or Long Flush.

Table 17. Average reproductive rate (lambs scanned per 100 ewes joined) for each site in 2015 to 2017.

Site No	Average reproductive rate (lambs scanned / 100 ewes joined)			
	Treatment			
	Control	Lucerne Short Flush	Lucerne Long Flush	Significance*
2015				
23	145 b	157 a	154 ab	P<0.05
24	156 a	157 a	161 a	NS
25	§	149 a	144 a	NS
2016				
26‡	105 ab	100 b	117 a	P<0.01
27‡	101† c	123 b	140 a	P<0.001
28‡	101† c	124 b	148 a	P<0.001
29	§	153 a	162 a	NS
2017				
30	165 a	165 a	170 a	NS
31	138 a	122 b	131 ab	P<0.01
32	142 b	151 ab	158 a	P<0.01

* Within a given row for predicted reproductive rate, means followed by the same letter a, b or c are not significantly different (P>0.05) NS – Treatment effect is not significant (P>0.05)

† The Control treatment was the same for both sites (experimental structure took account of this)

‡ Maiden ewes were included in the treatments. In previous years all ewes were mature

§ Compared short and long flush only due to limited number of ewes available

The data presented suggests there is no negative impact on ewe RR when grazing on lucerne throughout joining compared to a Lucerne Short Flush or grazing on dry pasture.

Impact of flushing maiden ewes on RR

The analysis showed there is no interaction for RR between treatment and ewe class for the three sites which used maiden ewes and adult ewes in 2016. This indicates the flushing response has occurred independent of the class of the ewe.

5.4.4 Impact of feed impact on CR

Impact of flushing on CR

Analysis of the 2015-2017 CR data (Table 18), for the eight sites which included the Control treatment, shows a significant increase in conception rate (ewes pregnant per ewes joined) at two Lucerne Short Flush sites (23,27) compared to the Control whereas one site (31) recorded a lower CR on the Lucerne Short Flush.

There were no significant differences in CR at two sites which included the Control treatment (24, 32) or at the two sites which did not have a Control treatment (25, 29).

Impact of joining ewes on the Lucerne Long Flush

In two (27, 28) Lucerne Long Flush sites there was a significant increase in CR compared to the Control treatment. A further two (26, 30) Lucerne Long Flush sites showed a significant increase in CR over the Lucerne Short Flush treatment.

Of interest is a significant increase in CR by 5 pregnancies per 100 ewes joined additional ewes scanned pregnant in the Lucerne Long Flush treatment at site 30 compared to the Lucerne Short Flush. The ewes had a heavy liveweight (Avg. 86.4kg) and high condition score (Avg. 4.6) overall at the start of the demonstration, indicating even at a heavy liveweight and condition score the conception rate can be increased through grazing lucerne throughout joining.

Table 18. Average conception rate (ewes pregnant per ewes joined) for each site in 2015 to 2017.

Site No	Average conception rate (ewes pregnant / ewes joined)			
	Treatment			
	Control	Lucerne Short Flush	Lucerne Long Flush	Significance*
2015				
23	92 b	97 a	94 ab	P<0.05
24	95 a	97 a	95 a	NS
25	§	84 a	87 a	NS
2016				
26‡	78 ab	74 b	83 a	P<0.05
27‡	93† b	97 a	97 a	P<0.05
28‡	93† b	96 ab	97 a	P<0.05
29	§	94 a	95 a	NS
2017				
30	96 ab	92 b	97 a	P<0.05
31	85 a	77 b	82 ab	P<0.01
32	96 a	94 a	94 a	NS

*Within a given row for predicted conception rate, means followed by the same letter a, b or c are not significantly different (P>0.05) NS – Treatment effect is not significant (P>0.05)

† The Control treatment was the same for both sites (experimental structure took account of this)

‡ Maiden ewes were included in the treatments. In previous years all ewes were mature

§ Compared short and long flush only due to limited number of ewes available

The results indicate there was no significant detrimental effect on the CR of ewes in the Lucerne Long Flush treatment compared to a Lucerne Short Flush or grazing on dry pasture as four sites recorded higher conception rates compared to the Control and Lucerne Short Flush treatments.

Impact of flushing maiden ewes on CR

Similarly to RR, the analysis showed there is no interaction for CR between treatment and ewe class for the three sites which used maiden ewes and adult ewes in 2016. This indicates the flushing response has occurred independent of the class of the ewe.

5.4.5 Feed test analysis and trends

An overview of the nutritive value of the pasture treatments from 2015-2017 demonstration periods are provided in Table 19. The project aimed to sample three times, once at the start of the demonstration period, again at the end of the short flush and at the end of joining. However, due to logistics, not all Control and Lucerne Short and Long Flush treatments were sampled at each site visit hence the feed test average value and nutritive range within treatments are presented.

Visual assessment of Control, Lucerne Short and Long Flush pastures were undertaken at each site visit to estimate feed on offer, species present and the condition of each treatment. All treatments, taking into account planned supplementation were assessed as having adequate feed availability to sustain ewes for the entire demonstration period. There were no incidences of poor quality due to foliar disease, fungus or insect infestation observed on any of the Control or Lucerne Short or Long Flush treatments.

The average metabolisable energy, protein, and water soluble carbohydrate of the Control (typical dry pasture) was fairly low compared to the sampled Lucerne Short or Long Flush treatments which were moderate to relatively high throughout joining. The average nutritive values are presented along with the range as some sites received rain during the demonstration period resulting in higher energy and protein values. Refer to Table A2 in Appendix 10.1 for individual site feed tests results.

Table 19. Average and range of metabolisable energy (MJ ME/kg DM), crude protein (CP%), neutral detergent fibre (NDF%) and water soluble carbohydrate (WSC%) of the Control (typical dry pasture available), Lucerne Short Flush and Lucerne Long Flush treatments based on a combination of samples taken 7 days prior to joining (Wt1) and 7 days after joining (Wt2) and at the end of joining (Wt3).

Feed test analysis	Treatment 2015, 2016. 2017			
	Control		Lucerne	
	Average	Range	Average	Range
Average of ME	7.3	5.0-9.6	10.3	8.8-11.5
Average of CP	10.8	3.7-17.1	23.1	16.8-29.5
Average of NDF	68.8	56.7-85.0	46.0	34.4-62.4
Average of WSC	4.8	3.0-6.0	4.6	2.67-7.5

Site 23 and 26 supplemented the control ewes with grain due to poor seasonal conditions resulting in negligible dry pasture. The grain fed out included barley, triticale and oats with a combined metabolisable energy (MJ ME/kg DM) of 12.67 and crude protein (CP%) value of 10.53.

6 Discussion

Grazing lucerne or other green feed for seven days prior to joining and seven days into joining was sufficient to flush naturally mated ewes at 17 of the 30 sites monitored with a dry feed control treatment. The number of ewes pregnant and number lambs scanned was higher, compared to ewes grazing the traditional dry pasture available at joining in late December to March for an autumn or winter lambing.

This demonstration project showed a reproductive rate advantage for the short term flushing on green feed compared to grazing ewes on dry pasture. There was a consistent trend with 20 of the 22 commercial properties in 2013-2014 displaying an increased reproductive rate on green feed. Of these 20 sites, 13 showed a statistically significant increase in reproductive rate ranging from 10 to 33 more lambs scanned per 100 ewes joined compared to grazing ewes for two weeks compared to typical dry pasture.

Conception rates in 2014 significantly increased on three of 15 sites, ranging from 4 to 13 extra pregnancies per 100 ewes joined from grazing ewes on green feed short term for two weeks compared to typical dry pasture.

Ewes fed lupins responded at five of the eight sites with an increase in reproductive rate ranging from 8 to 21 more lambs scanned per 100 ewes joined compared to the ewes on dry feed. This response was not as high as the response of the ewes flushed on green feed seven days before and seven days after joining.

In Phase 2, three of the eight sites showed a reproductive rate advantage in ewes grazed on lucerne throughout joining ranging from 16 to 47 more lambs scanned per 100 ewes joined compared to those on dry feed.

Furthermore, three sites recorded a reproductive rate advantage in ewes on the long flush over the short flush. The largest influence on increasing reproductive efficiency from flushing short or long term on green fed was through having more ewes producing twin foetuses. Overall, there were more pregnant ewes at some sites, however this was less of an influence on reproductive efficiency.

There appeared to be no disadvantage to ewe conception rate or reproductive rate from grazing lucerne throughout joining compared to a short flush on the majority of the sites as none of the 10 sites recorded a reduced reproductive rate and only one site recorded a reduced conception rate compared to typical dry feed. This is consistent a finding with [A]Robertson *et al.* (2015) however it is in contrast to a pen feeding study where ewes were fed fresh lucerne pasture ([B]Robertson *et al.* 2015). In this demonstration project, conception rate of ewes was measured by pregnancy scanning ewes at 80-90 days from the start of joining in lieu of embryo mortality as it could not be directly measured in this commercial project. However, the proportion of non-pregnant ewes in the long flush treatment was not measurably different to those in the other treatments. In addition, at all sites the ewes grazing lucerne throughout joining pregnancy scanned a similar, or at three sites a higher, number of foetuses per ewe joined compared to the control or lucerne short flush ewes. This indicates that in this project, embryo mortality in ewes grazing lucerne throughout joining was unlikely to be affected.

The presence of coumestans (a type of phytoestrogen) at 600ppm in lucerne leaf has been reported in previous research to reduce ovulation and lambing rate by 34% and 16.4% respectively in ewes (Smith *et al*. 1979). Therefore, it is recommended not to graze ewes on lucerne when it appears heavily diseased or nutritionally low quality. In this project all paddock feed sources, including Lucerne, were visually assessed at each site as being healthy. There was no evidence of lucerne paddocks appearing stressed from foliar disease, aphid infestation or fungal disease. Dried lucerne samples were stored in the event that reproductive issues for ewes grazing lucerne might be observed but coumestans were not measured in this study as it was out of the scope of this project. Only one site (31) showed significantly poorer reproductive rate results for the lucerne short flush treatment compared to the control treatment. This site is likely to have had other underlying reproductive issues contributing to poor results, and is discussed below (Section 6.2 Unexpected Outcomes).

[A]Robertson *et al.* (2015) reported no further benefits to ewe reproduction rates by continuing to graze ewes on lucerne beyond seven days of joining as 90% of ewes were found to be naturally mated in the first 14 days from the introduction of the rams. However, this project showed an increase in reproduction for both conception at three sites and reproduction rates at three sites for ewes grazing lucerne throughout joining. This indicates there may be benefits to joining on lucerne longer than the short flush in some cases; however, it was not within the scope of this project to identify the circumstances under which a benefit may be derived from the long flush. Consideration would need to be given to the potential reproductive benefits compared to utilising the lucerne more efficiently, including finishing lambs or increase the number of ewes flushed. For producers, such as those in cropping regions where stubbles are typically grazed but offer low nutrition, providing lucerne throughout joining may be a feasible alternative to provide optimum nutrition and maximise reproductive efficiency.

The reproductive response to increased nutrition from green feed appears to be independent of liveweight at joining, which was also observed by Killeen (1967). It appears to be similarly independent of condition score.

There was a significant change in liveweight observed between treatments and between each weighing within a treatment at the end of the short flush and at the end of joining for most sites. Change in liveweight during the flushing period does not appear to influence conception and reproduction rates as there was considerable variability in the response in conception and reproduction rate. Evidence of this is shown as some sites which had no difference in liveweight change between treatments yet showed a higher reproductive rate response for either the short or long flush on lucerne treatments, whereas other sites with significant differences in changes to liveweight between treatments showed no difference between treatments for conception and reproductive rates.

In this demonstration there was a range of average initial liveweight from 40.5 kg to 86.4 kg across sites. The average condition score between sites was similar for the majority of sites, ranging from 2.5 to 3.7 apart from one site with a 4.6 average. Where ewes are in heavier condition it would be expected flushing may have less influence on reproduction efficiency and this demonstration has generally supported this belief, although the site with highest initial liveweight and condition score did show a significant increase in the conception rate for the lucerne longer flush treatment over the short flush treatment.

Maiden ewes tend to exhibit a lower potential twinning rate compared to adult ewes and therefore it is surmised that their response to flushing may not be as successful. Three demonstration sites in Phase 2 of this project joined a proportion of maiden merino ewes aged approximately 15 months along with adult ewes on dry pasture and short or long flush on lucerne. At these sites, the maiden ewes showed a similar response as the adult ewes to flushing. Reproduction benefits in terms of both conception rate (up to 4 additional pregnancies per 100 ewes joined) and overall reproduction rate (up to 40 additional lambs scanned per 100 ewes joined) were observed at these three sites, suggesting that flushing maiden ewes on lucerne may be beneficial.

The optimum time to flush ewes is when feed quality is low, generally during summer and early autumn when senesced pastures and stubbles are dry. Ewes are less likely to respond to flushing in spring or early summer as they have generally had access to high quality feed during these seasons. Joining time varied within this demonstration from late December to the end of March, with the majority of sites joined in February and March. Although not statistically analysed, the time of joining did not appear to have any overall influence on reproductive efficiency between sites which is most likely due to the fact that ewes in this project were all joined within their natural breeding season.

The feed quality assessed during the course of the demonstration periods across each year showed a range in nutritive values. Although the dry senesced pasture tended to be lower in ME and protein than the green pasture or lucerne, this was not always the case. At two sites green feed emerged in the control paddocks during the demonstration period due to rainfall events. This increased the ME and protein of these samples and may have influenced reproduction rates as this site showed no difference between the short flush on green feed and the control treatment.

The concept of flushing is that it provides a highly nutritious feed supply (energy and protein) for a short period prior to joining to increase ovulation rates (Pearse *et al*. 1994). Although not analysed, it appears there was no apparent relationship observed between feed quality of the green feed used for flushing and the magnitude of the response in reproduction efficiency.

6.1 Project delivery

Project objectives met by Agriculture Victoria include:

1. Validate and demonstrate the impact of grazing lucerne or sources of green feed at joining on ewe reproduction at eight sites per year for two years across southern Australia.
    - 14 sites conducted in 2013-2014
2. Validate and demonstrate the impact of feeding lupins at joining on ewe reproduction at four of the eight sites per year across southern Australia.
    - Eight Control plus Lupin sites conducted in 2013-2014.
3. Validate and demonstrate the impact of grazing lucerne throughout joining on early embryo mortality.
    - Embryo mortality could not be directly measured in this project therefore it was indirectly measured by obtaining conception and reproductive rate data.
    - 10 sites conducted from 2015-2017.

- There was considerable interest in the project and although some producers were unable to participate as they did not meet the project requirements, they indicated they were very interested to obtain the results and recommendations at the completion of the project.
- In the project proposal, the delivery of two additional sites in 2013-2014 was specifically allocated to another agency. Due to unanticipated circumstances the other agency was unable to conduct the demonstrations.

6.2 Unexpected outcomes

Only one site (31) of the ten sites established in Phase 2 recorded a higher conception and reproduction rate in the control group compared to the lucerne short and long flush ewes. The conception rate for the control was poor (85%), indicating the presence of some underlying reproductive issues. It is possible that there were some other factors impacting the reproductive performance of these merino ewes, other than the lucerne provided in the flushing treatments, as the owners have historically recorded low reproduction results on their property. The following observations suggest that optimal conception rates should have been possible for this flock:

- The ewes were at an optimum CS of 3.1 and within a small range (83% between CS 2.75 and 3.25)
- The ewes had an optimal liveweight average of 62.8 kg across all treatments at the start of the demonstration and average liveweight did not fall below the initial liveweight by more than one kilogram for all treatments throughout the demonstration.
- Feed was not limiting and quality was assessed as high relative to the equivalent treatments in this project.
- Poor conception rates (77%-85%) but good multiple ovulations were observed when the ewes did conceive, as 55% of pregnant ewes scanned multiple foetuses.
- Rams are brucellosis tested as healthy

In an effort to increase reproduction two years ago the owners at this site purchased ewes from a merino flock known for producing ewes with high fertility. Approximately 30–40% of these purchased ewes were in each treatment group. Since all ewes were EID tagged the opportunity was taken to compare results for the homebred ewes with purchased ewes. The purchased ewes were distributed evenly between treatments and averaged an overall reproduction rate of 142%, compared to 123% for the homebred ewes, but still exhibited a low overall conception rate (86% for purchased ewes and 79% for homebred ewes).

Coumestans that may have been present in the lucerne were not measured in this study. However, it is likely other underlying reproductive causes contributed to the decreased CR and RR as the lucerne was visually healthy and did not appear stressed. A recommendation for this site would be a lucerne tissue test to look for the presence of coumestans as a potential factor impacting on ewe reproduction.

7 Conclusions/Recommendations

Short term flushing with green feed (lucerne, rape, millet or green pasture) provides a strong likelihood of achieving impressive reproductive benefits compared to ewes grazing dry pasture. Of the 32 sites monitored over five years, 13 Phase 1 and four Phase 2 sites responded with significantly increased reproductive rate from either a short or long flush, with the benefit being increases of up to 47 additional lambs scanned per 100 ewes joined, but more generally within the range of 20 – 30 additional lambs scanned per 100 ewes joined.

Furthermore, the conception and reproductive rate of ewes grazing lucerne for the entire joining period (long flush) were not negatively impacted. This project showed an increase in reproduction for both conception and reproduction rates for ewes grazing lucerne throughout joining at some sites which indicates there may be benefits to joining on lucerne longer than the short flush. Further work would need to be done to determine the circumstances under which the grazing of lucerne throughout joining is a feasible and economic option.

Grazing lucerne should however be avoided if a fungus is present or it is stressed by aphid attack as it can produce a chemical called coumestan that can impact on ewe fertility. Further research is warranted to determine factors contributing to the occurrence and presence of coumestans in lucerne and potential impact on ewe reproduction efficiency.

Implementing a simple but effective grazing management strategy that can provide a short term flush can increase lamb production and profit through generating a higher number of multiple births. The opportunity cost of flushing ewes versus finishing lambs or growing out weaners is a factor that needs to be considered prior to joining. For example, if there is a lower available feed base due to seasonal conditions then it could be more profitable to flush ewes than finish lambs. The benefit of flushing is an increase in the number of lambs born, but this requires a greater need to manage nutrition and mob size effectively for maximum lamb survival.

Consideration would need to be given to the potential reproductive benefits compared to utilising the lucerne more efficiently, including finishing lambs or increase the number of ewes flushed. For producers, such as those in cropping regions where stubbles are typically grazed but offer low nutrition, providing lucerne throughout joining may be a feasible alternative to provide optimum nutrition and maximise reproductive efficiency. A useful extension of this project would be a review of the currently available feed planning tools to assess their ability to effectively and profitably allocate green feed during summer and autumn between competing livestock classes (e.g. joining ewes, growing out weaners, finishing prime lambs), and modify them or develop a simple tool to assist producers to make such management decisions.

This project has provided some new insights into benefits of flushing ewes on lucerne under a range environments and management regimes on commercial properties. There would be considerable industry benefit from having this information made available in a scientific publication and conducting related extension.

8 Key messages

A flushing response to even small amounts of green feed occurs in most instances without grain supplementation. The information obtained from this project suggests there is no negative impact on ewe RR when grazing on lucerne throughout joining compared to a short flush or grazing on typical dry pasture.

This project provides information for producers to utilise and make better strategic decisions based on the feed base which can be used to maximise the reproductive performance in their ewe flock, grow out ewe replacements or finish lambs. Some strategic decisions for consideration include:

- Better utilisation when green feed is a limiting as it is reported that as little as 350KgDM/Ha (King *et al*. 2010) can generate a reproductive response. However, consideration would need to be given to the value of any potential reproductive benefits compared to utilisation of the feed source for other purposes such as including finishing lambs, growing out weaners or increasing the number of ewes flushed.
- Utilise green feed sources with a minimum of 350kg/DM/ha to flush ewes short term to increase ovulation (7 days prior and 7 days after joining).
- If due to seasonal conditions or other factors there is limited lucerne feed or green feed available it may be more cost effective to use lucerne for flushing ewes instead of lupins as long as management strategies can be put in place to manage any extra lambs born.
- If the available feedbase is unlimited then it might be a better tactical decision to set aside available high quality and high quantity lucerne or green pastures to finish lambs on, and use any remaining green feed to flush ewes as past research indicates that even minimal amounts of green feed can elicit a reproductive response.
- Lupins can be used to generate an increase in reproduction, however this grain can be difficult to source in some places and it tends to be less cost effective compared to available green feed. If green feed such as lucerne is not available then lupins offer similar benefits to increase the number of lambs born.
- A management strategy should be put in place to manage ewes carrying additional foetuses and lambs born.

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10 Appendix

10.1 Feed test analysis per site for 2014-2017

The average nutritive feed values for the Control, Green feed and Lucerne treatments from 2014-2017 for most sites are provided in Tables A1 and A2.

Table A1. Average and range of metabolisable energy (MJ ME/kg DM), crude protein (CP%), neutral detergent fibre (NDF%) and water soluble carbohydrate (WSC%) of the Control (typical dry pasture available) Green Feed Short Flush based on a combination of samples taken 7 days prior to joining (Wt1) and 7 days after joining (Wt2) for each site.

Site No	Average of ME		Average of CP		Average of NDF		Average of WSC	
	Control	Green feed	Control	Green feed	Control	Green feed	Control	Green feed
8	5.5	9.6	10.2	15.0	72.1	56.7		5.4
9	6.9	7.8	5.9	13.4	76.4	52.6	4.0	4.6
10	5.7	8.7	3.8	16.1	76.2	55.9	5.9	4.9
11	5.4	11.3	10.1	18.0	72.0	55.8		6.2
12	5.1	8.5	4.8	17.4	77.0	48.3	4.0	8.0
13	8.0	10.0	15.6	20.8	70.1	65.2	8.4	7.0
14	7.9	11.6	7.4	23.9	71.1	37.8	6.8	7.3
15 & 16	7.2	12.1	7.4	17.4	73.5	37.7	4.2	7.1
17 & 18	6.6	11.1	7.9	14.4	71.3	36.0	6.4	12.7
19	5.5	10.8	7.2	25.4	73.0	40.8	4.3	
21 & 22	3.0	10.7	3.3	21.8	79.5	42.4		6.3

Table A2. Average and range of metabolisable energy (MJ ME/kg DM), crude protein (CP%), neutral detergent fibre (NDF%) and water soluble carbohydrate (WSC%) of the Control (typical dry pasture available), Lucerne Short Flush and Lucerne Long Flush treatments based on a combination of samples taken 7 days prior to joining (Wt1) and 7 days after joining (Wt2) and at the end of joining (Wt3) for each site.

Site No.	Average of ME		Average of CP		Average of NDF		Average of WSC	
	Control	Lucerne	Control	Lucerne	Control	Lucerne	Control	Lucerne
23	5.5	8.9	7.9	18.0	77.9	55.3	6.0	5.7
24	5.6	9.0	6.5	16.7	75.9	62.4	5.8	7.5
25		10.0		24.5		43.0		5.9
26		11.1		27.4		41.7		
27		11.1		22.2		34.4		6.3
29	9.6	10.9	17.1	29.5	56.7	40.1	4.9	2.9
30	8.8	10.5	14.7	22.4	61.2	45.7	4.0	2.7
31	8.2	11.4	10.8	27.1	63.0	37.0	6.0	3.5
32	5.0	11.5	3.7	26.9	85.0	37.0	3.0	3.0