final report

Project code: B.FDP.0030

Prepared by: Ed Riggall, Georgia Reid and Kate Jefferies

Date published: 11 July 2017

PUBLISHED BY
Meat and Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

Whole farm profit of grazing crops

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

Executive Summary

The main aim of this trial was to identify the effect that crop grazing has on ewe condition score (therefore productivity) and crop yield in the Moora-Miling area of WA to determine a whole-farm perspective. This included potential changes to pasture quantity as a result of deferring pasture grazing through the use of grazing crops. The effect that time of sowing has on available Feed on Offer (FOO) of crops early in the season was also investigated.

Climatic conditions over the three years of data varied considerably, causing inconsistent results. Crop grazing was found to be consistently beneficial to the sheep enterprise and of particular value in tighter feed years. In general, the drier the year and less abundant the feed, the greater the benefits of crop grazing to the sheep enterprise. However, in drier years, the crop was less able to compensate for the effects of grazing, resulting in lower yields but overall a modelled net gain for the mixed farm enterprise.

Selective grazing was an issue in one of the years, with one area of the crop heavily grazed. This resulted in weeds out-competing the crop, reducing overall yields. The impact on crop yield outweighed the benefit to sheep, and a modelled net loss was the result.

This reinforced the Grain & Graze guidelines for crop grazing: 1) paddocks should have low weed burdens, and 2) paddocks should be grazed early and with a medium intensity to minimise the risk of selective crop grazing. This was one of the main learnings from the group's participation. If farmers adhere to these, the risk of reducing crop yield should be minimised.

The final year of the trial produced interesting results. A wet year with an abundance of feed, higher protein and energy levels in the crop enabled the ewes to gain slightly from grazing the barley compared with the pasture. The crop however benefited from being grazed. This was due to the impact of frost, which was avoided in the grazed crop, as grazing deferred flowering and therefore minimized the frost's impact. This resulted in a much higher modelled net income of $322.50/ha as a result of the crop grazing.

It was only possible to trial the effect of different sowing times in the final year of the trial. The favourable season reduced the effects of crop grazing on the ewes, although, on both farms, the ewes benefitted slightly from crop grazing compared to going straight onto pasture. Crop FOO was higher where the crop was sown earlier.

This project showed that mixed farming systems have a feed source that can be utilised to improve lambing ewes' condition scores, and therefore lamb survival. Having abundant feed on offer during lambing by deferring pasture during crop grazing can lead to increased lamb survival rates, especially in twins. If managed correctly, crop grazing can lead to overall net profits as the benefits to the sheep outweigh the impacted of crop grazing on yields (when managed appropriately). This will help reduce time and money spent on supplementary feeding, as well as increasing ewe productivity.

Further research is required to validate these results, due to so much weather variation, as well as looking into the impact of crop type and variety, sowing time, climatic impacts and the potential to reduce frost risk.

Table of Contents

1 Background 4
2 Projective Objectives 4
The objectives were as follows: 4
By 15th April 2017, have: 4
1. Identified the effect that crop grazing has on crop yield in the Moora-Miling area. 4
2. Investigated potential changes to pasture quantity, as a result of deferring pasture grazing through the use of grazing crops. 5
3. Investigated the effect that time of sowing has on available Feed on Offer (FOO) early in the season. 5
3 Methodology 5
3.1 Research Sites 5
3.2 Treatments 5
3.3 Monitoring 5
3.4 Statistical Analysis 6
3.5 Economic Analysis 6
3.6 Extension and Communication 7
4 Results and Discussion 7
4.1 Measured trial results 7
4.1.1 Outcomes in achieving objectives: Trial Complications 7
4.1.2 Effect on Ewe Condition Score, Lamb Survival and Deferred Pasture 8
4.2 The Research Group and Process 13
5 Conclusions 16
6 Bibliography 17

1 Background

The producer group (Moora-Miling Pasture Improvement Group) consists of nine core members in the Moora-Miling area managing 80,000 sheep over 30,000ha. The area is within the Mediterranean climatic zone of WA, with around 460mm rain/annum. Farms in the area are generally mixed, producing sheep, cereals and canola. The group has been active since 1939, with the aim to improve the efficiency of farming in their area by investigating opportunities and disseminating information (www.mmpig.org.au).

Farmers in the core group were aware of previous research by DAFWA, as well as the Lifetime Wool and Lifetime Ewe projects, clearly demonstrating the link between ewe conditions and lambing rates (Curnow, M, 2006; Gibb & Treache, 1980; Oldham et al., 2011). The research showed that the bodyweight and condition score (CS) of ewes at all stages of the reproductive cycle had an impact on successful lambing percentages, lamb survival and growth rates, especially in twin bearing ewes.

Likewise pasture availability and feed on offer (FOO) at late pregnancy/lambing also has a strong link with lamb survival, an impact more apparent in twin bearing ewes (Lloyd Davis, H, 1987). Not only does the combination of increased ewe condition score and feed availability increase lambing percentage, it also has a positive lifetime impact for the lamb resulting in heavier weaners, in addition to setting the ewe up in better condition for summer as she comes out of lambing.

Spending time and money supplementary feeding ewes to increase their productivity, the group became interested in crop grazing, but were concerned, as most farmers are, that crop yields would be affected by crop grazing. Several farmers in the area have started to graze crops, and there was a strong desire to quantify this from a whole-farm profit perspective. This resulted in the group putting forward a proposal to investigate the comparative benefits of dual purpose crop grazing for sheep and the potential disadvantage to the crop.

There are many different methods of grazing crops, such as using standing crops, or sacrificial grazing during the mid-late reproductive phases. However, these methods significantly reduce crop yields, and are therefore not profitable to the Moora group. Grazing crops during the late vegetative and early reproductive phases allows the crop to recover, with minimal impact on yields. This is known as dual-purpose crop grazing (Anon, 2007). Previous work, in particular by Grain & Graze has shown that for dual-purpose crop grazing to be successful, it requires careful management. Paddocks must have low weed burdens, be grazed early to allow the crop to recover, and with a medium intensity (Nicholson et al. 2016).

2 Projective Objectives

This project formed part of MLAs Producer Research Site program that was part of the southern Feedbase Investment Plan. In particular, this project supported the MLA-funded project *B.GSM.0008 - Step changes in meat production systems from dual-purpose crops in the feedbase.*
The objectives were as follows:

By 15th April 2017, have:

1. Identified the effect that crop grazing has on crop yield in the Moora-Miling area.

2. Investigated potential changes to pasture quantity, as a result of deferring pasture grazing through the use of grazing crops.

3. Investigated the effect that time of sowing has on available Feed on Offer (FOO) early in the season.

3 Methodology

3.1 Research Sites

Farms within the Moora-Miling area managed by core members of the producer group were selected for the trial. The two sites had similar soils, climate and practices. Selection criterion was based on willingness and ability to carry out the treatment requirements over the three year trial.

The farms needed to have:

- Suitable paddocks of similar size and history
- Able to fit barley in the rotation.
- Sheep due to lamb in June / July, that had been scanned for twins.

The two properties had similar history and management strategies, comprised of 70% cropping and 30% sheep. The cropping enterprises focus on wheat, lupins and canola, and often include barley or oats. As cropping is dominant on these properties, chemicals are heavily used for weed control. Radish is a common weed in the area, as is ryegrass and capeweed which are components of their pastures, along with the sown clover. The soil type in the area ranges from sandy duplexes to heavy red loams, with both sites comprising of sandy loams.

3.2 Treatments

The research sites were set up for a paired paddock trial. Each paddock was approximately 30ha, with similar historic yields, to allow realistic comparisons. This method was repeated each year for the duration of the trial, with the farmer carrying out his usual weed control and fertiliser applications to each paddock during the project.

One of the paired paddocks was dry sown on May 1 each year and the other sown after the break of the season (Mid May), with Hindmarsh barley. Normal pasture paddocks were also set up on each host property during May, to allow grazing deferral to be tested.

A mob of twinning ewes of equal condition score, due to lamb in June/July each year of the trial, were split between one of the crop paddocks, and the pasture they would normally be grazing. They were both grazed at the same stocking rate (10DSE/ha) for the same duration. This was until they were two weeks from lambing (or they/the crop was showing signs of distress), a duration of 3-4 weeks.

3.3 Monitoring

All ewes were condition scored before and after the crop grazing period to enable comparisons to be made. The condition of the sheep and crop were checked regularly by the farmer to minimise any risks involved with the experiment, such as sheep or crop stress.

Measurements of 0.1 square metre cuts were taken from the crop paddock as sheep were about to enter it to commence grazing, as well as from the pasture paddocking. When grazing finished, samples were taken again from the deferred pasture cages. These feed samples were tested for quantity of FOO (kg/ha of dry matter) and quality (crude protein as a percentage of dry matter, metabolisable energy as a percentage of dry matter). This enabled us to monitor the impact of grazing on FOO, as well as the impact of feed quality and quantity on sheep condition changes.

Harvest yields were recorded in the grazed and non-grazed barley crops on each farm through use of a weigh trailer or using the farmer's yield monitor within the harvester if it was accurate and recently calibrated.

All factors that may have affected the trial results were recorded, such as climatic conditions and supplementary feeding.

3.4 Statistical Analysis

The results of the three years were all compared in order to determine trends and anomalies.

Feed test quantity results (FOO) were compared between paddocks (crop, pasture, deferred pasture) each year to analyse the impact on sheep condition, and impact of sheep grazing on feed on offer. However, the first year's data had considerable variation in quantity, so quality results were undertaken as well for years 2 and 3 of the trial, to allow further comparisons.

Average ewe condition score for each treatment was compared, and the advantage of grazing crop analysed. This was the increase in condition gained by grazing the crop compared to the pasture, known as the comparative advantage.

Harvest results (t/ha harvested as well as t/ha left in paddock) were recorded in the grazed barley paddocks and equivalent non-grazed barley paddocks, in order to monitor the impact that crop grazing had on crop yield and income.

Using both the crop yield and increases in condition score, whole farm profits were modelled to see the overall financial impact of crop grazing.

3.5 Economic Analysis

Economist John Young's model was utilised, the Lifetime Ewe Management Model, looking at the financial impact of condition score on sheep margins. This was used to compare the condition score change between the pasture and crop grazing mobs to establish the comparative value and model the value of crop grazing in terms of increased sheep production. This estimate of increased sheep production value was then used to calculate the value of crop grazing to the farmers by subtracting the value of barley yield difference in the grazed crop paddocks.

Previous trials carried out by Andrew Thompson of Murdoch University enabled the modelling of lamb survival at different FOO levels, where the amount of FOO during lambing impacted survival rates.

3.6 Extension and Communication

Field days were carried out for members of the group to get involved with the trial and discuss results, as well as to increase understanding of crop grazing in the wider community.

In autumn each year a day was organised to coincide with when the ewes commenced crop and pasture grazing. Group members condition scored the ewes carried out pasture cuts and divided the ewes into their two groups, releasing them into the crop and fresh pasture. Through this day the participants revised their understanding of condition scoring and measuring FOO, and gained a greater understanding of decisions surrounding timing of crop grazing. In the two later years of the trial, results from the previous years were discussed in relation to the current year.

Another day was organised in spring each year, after the ewes had come out of the crop and initial results were in. This worked well as farmers were not too busy at this time and could attend. Results were discussed in relation to the season, and compared with previous years. Attendees were able to view the ewes and crop alongside the results.

Articles were written for the MMPIG newsletters in August and January annually and circulated through their membership base.

.

4 Results and Discussion

4.1 Measured trial results

4.1.1 Outcomes in achieving objectives: Trial Complications

The three different years of this trial produced inconsistent results due to variable conditions, which shows the extent to which weather, in particular rain, and other factors such as weed burden affect the value of crop grazing. It can be concluded that despite inconsistent results, this trial has given members of the group greater understandings of what affects crop grazing and by what degree, enabling them to determine where, when and to what extent crop grazing could be beneficial to them. The project objectives were achieved, however our trial design and analysis had to be continually altered to take into account events out of our control, such as weather.

Project objective	Outcome
1. Identify the effect that crop grazing has on crop yield in the Moora Miling area.	Gained worthwhile results in three different situations; high weed burden, below average rainfall year, above average rainfall year. This led to decreases of 12.5% and 20%, with one year recordind gains of 18% in crop yield.
2. Investigate potential changes to pasture quantity as a result of deferring pasture grazing through the use of grazing crops.	Gained worthwhile results in three different rainfall years, showing farmers that deferring pastures where possible is worthwhile, increasing FOO by 250% in the 2016 trial. Repeat years would be useful to further corroborate the results, matching season to results.

3. Investigated the effect that time of sowing has on available Feed on Offer (FOO) early in the season.	This objective was hindered by the growth of a short season variety in year 1 and the false break in year 2. Although it was trialled successfully in year 3, the unusually wet year influenced results, so cannot be used by farmers to make decisions on timing of sowing for crop grazing. The earlier sown crop had higher FOO compared to the later sown, which had higher quality feed.

Several changes to the method were required over the three years due to seasonal variation, such as altering sowing time due to differing seasonal break times, or hand feeding during grazing as there was inadequate feed to meet the sheep's requirements.

2014: Hindmarsh barley was sown, which is a relatively short season barley variety. After seeding two paddocks a month apart, the decision was made that the later sown variety did not have sufficient time to mature to withstand grazing, so only the earlier sown crop was grazed. Yearly rainfall was 330mm compared to the average 460mm per annum.

2015: A false break reduced the length of time that the crop could be grazed without damage and enforced supplementary feeding (750g barley/head/day) for the mob on pasture. This also meant that the early and late sown crops germinated at the same time, so we could not compare the impact of sowing time. Total annual rainfall was 240mm.

2016: The break of season came early with no problems (other than too much water in places, with 480mm this year) so the effect of time of seeding could be trialled.

4.1.2 Effect on Ewe Condition Score, Lamb Survival and Deferred Pasture

Each year, the average ewe CS increased more in ewes that grazed the crop rather than those on the pasture (Table 1). This implies that the feed provided more energy than their average energy requirement in late pregnancy, meaning that twin bearing ewes were able to put on condition as feed availability exceeded this (Curnow et. al., 2011). The degree to which the crop advantaged the ewes over those grazing pasture can largely be explained by the years' varying rainfalls, therefore affecting pasture availability.

Crop grazing enables the deferring of pasture paddocks during the crop grazing period, which has been shown to significantly increase FOO for sheep coming out of the crop. This is a valuable feed source for the crop grazing mob if returned to that paddock after crop grazing, bringing additional value to the practice of crop grazing. However, the feed test results for 2015 and 2016 in Table 2 show that barley has consistently higher protein and energy levels than grass, and as well as being more accessible (more erect), makes it a valuable feed source.

The impact of levels of FOO during lambing has been modelled (Table 3), showing that if lambing onto the deferred pasture paddocks, with more FOO, lamb survival rates can increase in both twin and singles. There was less of an impact on singles once 95% survival was reached, and only little improvement in twinning rates over 1,700 kg/ha FOO. Overall, the increased FOO during lambing seemed to have more of an impact on twin lamb survival than single lambs.

In 2014, the ewes were able to graze the crop for a month. Although feed quality was not measured in 2014, FOO of deferred pasture was three times more than FOO of non-deferred pasture that had been grazed in the trial, leading to a modelled 18% increase in twin survival and 7% in singles lambs.

In 2015, low rainfall meant that FOO was low in all paddocks, as confirmed by the feed test results in Table 2. FOO in the deferred pasture was more than double that in the grazed crop, at slightly lower digestibility / metabolisable energy, but higher protein.

Table 1 shows that ewe CS was advantaged most significantly in this year by crop grazing, with the ewes on pasture losing condition. To further increase the significance of the CS results, ewes on pasture required supplementary feed of 750g barley/head/day for the duration of the trial. The higher levels of energy and accessibility of the crop enabled the crop grazed ewes to out-perform the pasture mob, even with their supplement feed. Table 3 shows the impact of this on lamb survival, with lower increases due to the deferral than 2014, with 10% increase in twin survival and 5% in singles. The grazed crop FOO result was higher than 2014's, possibly because the ewes were only able to graze the crop for three weeks before it was stressed.

In 2016 the season started earlier than usual. Weather conditions were abnormally wet, giving abundant FOO as shown in Table 2, where ewes effectively had adlib feed. It is surprising that the ewes on the crop gained such high CS considering the low FOO by the end of the trial in the crop. This further confirms the importance of feed quality and accessibility, with protein, energy levels and digestibility all higher in the crop than the grass in 2016. FOO in the deferred pasture was nearly twice as much as the grazed pasture, at slightly lower quality and two and a half times the FOO of the grazed crop. This led to no increase in single lamb survival and a 10% increase in twin survival rates.

Year	Mob- Twins	Date of Initial CS	Date of follow-up CS	Initial CS (mob av.)	Follow-up CS (mob av.)	Condition Score Increase	% Increase	CS Variation	% Variation
2014	Pasture ewes	30/05/2014	1/07/2014	2.41	2.78	0.37	0.2	-0.26	-0.1
2014	Crop grazing ewes			2.41	3.04	0.63	0.3	0.63	0.1
2015	Pasture ewes	9/06/2015	30/06/2015	3.2	3.03	-0.17	-0.1	-0.65	-0.2
2015	Crop grazing ewes			3.2	3.68	0.48	0.2	0.65	0.2
2016	Pasture ewes	30/05/2016	20/06/2016	3.5	3.9	0.4	11.4	0.1	2.9
2016	Crop grazing ewes			3.5	4	0.5	14.3	-0.1	-2.9

Table 1: Condition Score of ewes before and after grazing different treatments

Feed Test	Grazed Pasture			Deferred Pasture			Grazed Crop		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Metabolisable Energy (MJ/kg DM)		10.2	6		9.8	5.6		13.25	10.7
Crude Protein (% of DM)		24.5	17.5		28.3	16.8		39.35	19.9
Dry Matter Digestibility (%)		68.9	44.2		66.5	41.9		86.45	71.8
FOO (Kg/ha)	500	231.3	1238	1,700	603	2409	500	750	485

Table 2: Feed analysis of pasture and crop- Initial crop and pasture compared to final deferred pasture gains

Year	Pasture	FOO (kg/ha)	Single Survival (%)	Twin Survival (%)
2014	Grazed	500	88	64
	Deferred	1700	95	82
2015	Grazed	231.3	84	55
	Deferred	603	89	65
2015	Grazed	1238	95	75
	Deferred	2409	95	85

Table 3: Modeled Lamb Survival when lambing onto different pasture treatments

4.1.3 Effect on Crop Yield

The effect of crop grazing on crop yields is dependent on the ability of crop to recover from a reduction in biomass. Whatever the conditions, this could be controlled by managing stocking rates, although in a difficult year or a weedy crop with lots of competition for resources, ideal stocking rate may be so low that it would be unviable. The final year of this trial showed that crop grazing can be beneficial to crop yield in the right conditions. The issue is balancing the benefits to sheep with the impact on yields. When conditions were poor and plant growth restricted, feed was more valuable, but the sheep did more damage to the crop as it was less able to recover from grazing. When conditions were favourable, feed was plentiful with or without crop grazing, reducing its value to the sheep, but the crop was more able to compensate and even benefit from grazing.

In 2014 conditions were reasonable and the sheep were able to graze the crop for a month. However, they appeared to heavily selectively graze an area of the paddock, allowing weeds to out-compete the crop. This significantly affected crop yield in that area, but also reduced total paddock yield by 20%, or 0.6t/ha as show in Table 4. This was supported by existing research, which concluded that crop grazing should only be used on paddocks with low weed burden.

2015 was a poor season, starting with a false break. Combined with earlier lambing, this reduced crop grazing to three weeks. As a result, effect on yield cannot be directly compared to 2014's results. The sheep grazed the crop more evenly than they did in 2014 and the low weed burden in the paddock prevented the issues with competition that affected results in 2014, with a 12.5% (0.5t/ha) reduction in yield (Table 4).

2016 brought very favourable growing conditions, with an early break and plenty of follow-up rain. This enabled the crop to grow more quickly than the sheep could graze it. In response to this, the farmer decided to double the stocking rate of sheep on the crop for three weeks. As Table 4 shows, the grazed crop performed better than the un-grazed crop by 0.7t/ha- an advantage of 18% increase. This is due to manipulating the flowering window to avoid frost.
The outcomes of this research site enforced the message of Grain and Graze that paddocks should have low weed burdens, be grazed early and with a medium intensity to minimise the impact of crop grazing on crop yields.

Year	Plot	Grain Harvested	Grain Left in Paddock	Total	Impact on yield (%)	Value of yield impact ($ /ha)[A]
2014	Ungrazed (tonnes/ha)	2.37	0.63	3		
	Grazed (tonnes/ha)	1.5	0.9	2.4	-20	-$ 138.60
2015	Ungrazed (tonnes/ha)	4	0	4		
	Grazed (tonnes/ha)	3.5	0	3.5	-12.5	-$ 115.50
2016	Ungrazed (tonnes/ha)	4.36	0	4.36		
	Grazed (tonnes/ha)	5.15	0	5.15	18	$ 312.50

[A] Based on feed barley price of $231/tonne

Table 4: Analysis of barley yields in grazed and ungrazed crops

4.1.4 Effect of Date of Sowing on the Value of Crop Grazing

Due to the short season variety in 2014 and false break in 2015, only one season was capable of investigating the effect of sowing date on the value of crop grazing. More trials over a variety of seasons would be needed to make any conclusions on the effect of sowing date on the value of crop grazing.

In 2016, crops were sown 5 days apart. This was a wet season, allowing both crops and the pasture to grow well. Table 5 shows that the ewes benefitted slightly from crop grazing compared with going straight onto pasture, with an increase in CS. This was more significant in the later sown crop, where the ewes on pasture lost condition slightly.

Table 6 shows that FOO was higher where the crop was sown earliest on Mr Humphrey's farm. Feed tests were taken only one day apart and the pasture as well as crop showed lower FOO at Cranmore, suggesting that there may be reasons other than sowing date for this difference. In general, feed quality was higher where the crop was sown latest, probably due to a slower growing season with less water so more concentrated nutrition.

Farm / sowing date	Mob- Twins	Date of Initial CS	Date of follow-up CS	Initial CS (mob av.)	Follow-up CS (mob av.)	Condition Score Increase	% Increase	CS Variation	% Variation
R Humphrey's farm; earliest sown (05/05/16)	Pasture ewes	30/05/2016	20/06/2016	3.5	3.9	0.4	11.4	0.1	2.9
	Crop grazing ewes			3.5	4	0.5	14.3	-0.1	-2.9
Cranmore Farm; later sown crop (10/05/16)	Pasture ewes	31/05/2016	21/06/2016	3.08	2.98	-0.1	-3.2	0.6	19.5
	Crop grazing ewes			3.08	3.39	0.31	10.1	-0.41	-13.3
Difference between Farm data	Pasture ewes	same length of time, done day apart.		0.42	0.92	0.5	14.7	-0.5	-16.6
	Crop grazing ewes			0.42	0.61	0.2	4.2	0.3	10.5

Table 5: Comparison between Farms and Date of Sowing; Condition Score (CS) Results Before and After Crop Grazing Period

Feed Test	R Humphrey's farm; earliest sown (05/05/16)	Cranmore Farm; later sown crop (10/05/16)	R Humphrey's farm; earliest sown (05/05/16)	Cranmore Farm; later sown crop (10/05/16)	R Humphrey's farm; earliest sown (05/05/16)	Cranmore Farm; later sown crop (10/05/16)	R Humphrey's farm; earliest sown (05/05/16)	Cranmore Farm; later sown crop (10/05/16)
	Grazed Pasture		Un-grazed Pasture		Grazed Crop		Un-grazed Crop	
Metabolisable Energy (MJ/kg DM)	6	7.1	5.6	9.75	10.7	12.5	12.85	12.85
Crude Protein (% of DM)	17.5	19.05	16.8	13.35	19.9	36.85	34.2	34.2
FOO (Kg/ha)	1238	851.5	2409	1140	485	277	854	527

Table 6: Comparison between Farms and Date of Sowing; Quantity and Quality Results for Pasture and Crop Before and After Crop Grazing Period

Calculation	R Humphrey's farm; earliest sown (05/05/16)	Cranmore Farm; later sown crop (10/05/16)	Units
Increase in FOO over the 21 days grazing	329	201	kg DM/ha
Increase in FOO over the 21 days not grazed	698	451	kg DM/ha
Difference to the crop made by grazing	368	250	kg DM/ha
Difference to the crop per day	18	12	kg DM/ha/day
DSE (both farms used twin bearing ewes; 2DSE per animal)	10	4	DSE
Difference to the crop per sheep	3.5	2.98	kg DM/ewe/day
Crop growth per day	33.2	21.5	kg DM/ha/day

Table 7: Crop Growth Analysis

Feed samples were also taken from the crop in order to determine the amount of feed eaten by sheep on each farm, as well as looking at differences in pasture growth rates caused by different sowing times. Our results (Table 7) showed that growth rates and FOO increases were significantly lower in the later sown crop, in both the grazed and un-grazed paddocks. This makes sense, as the crop has had less time to establish and enters a period of cold temperatures which naturally slow growth rates.

The results, in Table 7, were analysed down to per sheep per day. These results indicated that the feed samples may not be representative of the paddocks, as it is not possible for a ewe, even in late stages of pregnancy, to consume the amount of kg DM required to result in the CS gains of Table 5. The inaccuracy is not surprising, as only small samples were taken so inaccuracies are easily magnified. For a more accurate look at pasture growth rates, the "Pasture from Space" website was used, which recorded approximately 19kg/DM/ha/day growth rates. (http://www.pasturesfromspace.csiro.au/map/pgr_mapservice.asp)

4.1.5 Economic Analysis

Previous research, particularly involving Lifetime Ewe Management (Thompson et. al., 2011; Edwards et. al., 2011; Oldham et. al., 2011) has shown that an increase in condition score during

pregnancy has been found to significantly benefit lambing percentage, particularly in twin bearing ewes. This is evident in the results from Andrew Thompson's model, in Table 3. Further modeled data in Table 8 provides an estimate of the financial effect of crop grazing on the overall farm enterprise using John Young's model. The effect on the crop gross margin, as calculated in Table 4, provides an evaluation of the net economic impact on the farm as a whole.

In 2014, a reasonable season meant that both the crop and pasture grazed ewes did well, so the advantage of crop grazing to the sheep enterprise was relatively small at $41/ha. The uneven grazing and weed burden in the paddock had a negative impact on crop yield, which out-weighed the benefit to the sheep, resulting in a modelled net loss to the farm that year.

2015, a poor year, meant that sheep benefitted significantly from crop grazing, as FOO in the pasture was low. The farmer also had the added expense of supplementary feed for the ewes on pasture, further increasing the value of crop grazing. Although crop yields were affected by the grazing, the reduction in crop gross margin was outweighed by the benefits to the sheep enterprise, resulting in a small net gain.

In 2016, the abundance of feed meant that ewes did not benefit significantly from crop grazing. Higher protein and energy levels in the crop enabled the ewes to gain slightly from grazing the crop compared to the pasture. However, the crop benefited from being grazed, producing a higher yield than the un-grazed paddock. This resulted in a much higher net income per ha, therefore an increased net gain.

Year	Modelled Benefits Per Ewe Utilising LTEM CS Comparison	Net Benefits After Modelling +Feed & Labour	Value Proposition@ 10 DSE/HA(Twin Ewes @ 2 DSE Rating)5 Ewes/HA	Crop Variation	Net
2014	$8.20	$8.20	$41	-$138.60	-$97.60
2015	$19.00	$24.64	$123.18	-$115.50	$7.68
2016	$2	$2	$10	$312.50	$322.50

Table 8: Modelled Economic Effect of Crop Grazing on the Sheep & Crop Enterprises, and Farm as a Whole

4.2 The Research Group and Process

4.2.1 Extension and Communication

Date	Activity	Number of people
May 2014	Field day- Combined condition scoring / FOO calculations and crop grazing session with dividing up of mob and measurements	*12*
July 2014	Field day- Combined condition scoring / FOO calculations and crop grazing session with dividing up of mob and measurements	10
September 2014	Field Day- Following lamb marking got group together to discuss results and observe pastures and crop variations	8
August/September 2014	MMPIG Newsletter- outlining activities and early results (following lamb marking)	Distributed to membership base of

		70
December 2014	Following harvest, results prepared article to analyse first year's data for MMPIG newsletter.	70
June 2015	Field day- Combined condition scoring / FOO calculations and crop grazing session with dividing up of mob and measurements	10
August 2015	Mid-year report for MMPIG group	70
September 2015	Field Day- Following lamb marking got group together to discuss results and observe pastures and crop variations	8
August 2015	Attended MLA Research Networking event in Perth	2
December 2015	Following harvest results, prepared article to analyse first year's data for MMPIG newsletter.	70
June 2016	Field day- Combined condition scoring /FOO calculations and crop grazing session with dividing up of mob and measurements	10
September 2016	Field Day- Following lamb marking, got group together to discuss results and observe pastures and crop variations	11
December 2016	Following harvest, results prepared article showing and discussing all 3 years' data for MMPIG newsletter.	70

4.2.2 Value of the Research Results (Benefits/Costs)

The hands on nature of this trial meant that the producer group was heavily involved from start to finish, enabling them to master condition scoring and feed testing, and seeing the results themselves. This involvement gave them a deeper understanding of the trial method and results, including the reliability of results, as well as valuable knowledge of the methods involved. This included understanding the impact of ewe condition on lamb survival, how to condition score and estimate FOO levels on their own farms, and gave them greater understanding of the importance of FOO and it's interaction with feed quality parameters. The group members also forged friendships through their interactions and were able to discuss topical subjects, prompting discussion about other farming issues and exchange of ideas and practices.

Members of the group have expressed an interest in trialling crop grazing on their own farms, having gained confidence through their involvement with this project. As the results show, there are significant financial benefits, deferring pastures and rotating paddocks more efficiently to maximise feed availability. The process of crop grazing is relatively low in labour and input costs, so are the risks, as long as they bear in mind stocking rate, crop recovery time and weed burden issues.

Table 4 in the results section gives a clear representation of cost benefit analysis in this trial.

4.2.3 Participant Reactions and Promotion of Research Results

The trial successfully raised awareness about the pitfalls of crop grazing in the area, leading the MMPIG group to better understanding how to manage crop grazing. In addition, its benefits were quantified, assisting farmers in weighing up the risk and benefits of using crops as a sheep management tool. Several of the core group members have tried or genuinely considered crop grazing as a result, but more importantly, the wider MMPIG community have the knowledge to do so successfully when needed, such as in a dry year. This was achieved through constant communication with the wider community, with publications and updates easily accessible, as well as the field days. The increased crop yield result in 2016 was unexpected and encouraging, and sparked interest in a wider population of farmers than was anticipated.

Members gained or improved useful on-farm skills, such as pasture assessments for FOO, and condition scoring, valuable skills in sheep and pasture management which many have applied to their enterprises. Another benefit of the trial is the immeasurable significance of open communication, with the exchange of ideas and experiences. Throughout the project, farmers were interacting with each other, discussing different practices and new possibilities, passing on knowledge. This helped reveal some gaps in the project's research, such as the reliance on unpredictable weather, impacts of variety or crop type, as well as potential future projects or trials.

4.2.4 Producer Research Site Program and Effectiveness of the Participatory Research Process

Producers in the core member group were genuinely interested and invested in the project. This kept them motivated as they wished to see the results, and whether crop grazing was a viable option in their area. Their direct involvement, either as a host for the trial or at field days, meant that they were always engaged, and had a say in the research methods, especially as changes were needed to be made to take into account weather and variety issues.
It should also be noted that the trial hosts now believe grazing crops to be an essential part of their business. They can also not speak highly enough of the benefits of hosting a trial, not just for the greater good of farming in their area but for the benefits too their own business.

Constant communication between the core group, wider community and the facilitator meant that the group was kept on track and had a positive, educational experience that was made relevant to their farming systems. Feedback showed that these attributes strongly contributed to the success of the project.

Throughout the project, other areas for investigation were identified, as previously discussed. These included the impact of crop variety and type, sowing time, and the reduced frost risk due to altering flowering time.

Another idea discussed was grazing an alternative high-value animal on the crop, such as finishing out of season lamb. Focusing on the high value animals justifies the risks of crop grazing. As both twin bearing ewes and out of season lambs are high value animals, either could be used and benefit from grazing crops.

5 Conclusions

The group concluded that crop grazing is a potentially valuable opportunity to benefit their sheep enterprise without significantly affecting their cropping yields – but only if key crop grazing principles are adhered to. Through the complications of the trial they gained a greater understanding of how to manage the tool and when and where it may be appropriate to use on their own properties. The main practical conclusions that were reached and quantified were:

- Crop grazing is beneficial to the sheep enterprise, as sheep condition score directly impacts lamb survival, particularly in twin bearing ewes.
- Crop grazing enables pasture grazing to be deferred, significantly increasing pasture quantity available after that time.
- In favourable conditions, crop grazing can actually benefit crop yields
- The effect of crop grazing on crop yields can be managed by ensuring that the crop does not become grazed to a degree from which it cannot regenerate successfully, either because of:
    - Time – if the remaining season length post grazing is too short to allow the plant to recover,
    - Rainfall / other factors limiting plant growth – if the plant is unable to gain the resources that it needs to compensate from grazing before harvest,
    - Competition – If weed burden is high enough to out-compete the cereal, and
    - Severity of grazing – If the plants are left with insufficient energy to re-grow efficiently.

This can be minimised by grazing paddocks with low weed burdens, graze early using the 'pull and twist' technique, and with a medium intensity.

6 Bibliography

Anon., (2007) “Grazing cereal grain crops-a discussion paper for Grain and Graze” available at: http://www.grainandgraze3.com.au/resources/13_45.pdf, accessed 20.3.17

Curnow M, (2006) Lifetime Wool-Ewe Management Guidelines, Department of Agriculture and Food Western Australia, Perth

Curnow M, Oldham CM, Behrendt R, Gordon DJ, Hyder MW, Rose IJ, Whale JW, Young JM, and Thompson AN, (2011) Successful adoption of new guidelines for the nutritional management of ewes is dependent on the development of appropriate tools and information *Animal Production Science* **51,** 851-85

Gibb MJ and Treache TT, (1980) The effect of ewe body condition at lambing on the performance of ewes and their lambs at pasture, *The Journal of Agricultural Science*, **95,** 631-640

Hocking Edwards J, Copping K, & Thompson AN, (2011) Managing the nutrition of twin bearing ewes during pregnancy using Lifetimewool recommendations increases production of twin lambs. *Animal Production Science*, **51**, 813-820

Lloyd Davis H, (1987) Studies on times of lambing ewes grazing subterranean clover based pastures in relation to stocking rates in south-western Australia. Technical Bulletin 72, Department of Agriculture and Food, Western Australia, Perth.

Moora-Miling Pasture Improvement Group, 2013, available at: www.mmpig.org.au

Nicholson C, Friscke A, Barret-Lennard P, (2016) “Grazing Cropped Land” Grain Research and Development Corp, Canberra

Oldham CM, Thompson AN, Ferguson MB, Gordon MJ, Kearney GA, Paganoni BI, (2011) The birth weight and survival of Merino lambs can be predicted from the profile of live weight change of their mothers during pregnancy. *Animal Production Science,* **51**, 776-783

Pastures from Space Plus, 2014 available at: www.pasturesfromspace.csiro.au/map/pgr_mapservice.asp, accessed 20.3.17

Thompson AN, Ferguson MB, Campbell AJD, Gordon DJ, Kearney GA, Oldham CM, Paganoni BL (2011) Improving the nutrition of Merino ewes during pregnancy and lactation increases weaning weight and survival of progeny but does not affect their mature size. *Animal Production Science*, **51**, 784-793