final report

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Lake Grace Final Report

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Executive Summary

This project aimed to investigate different legume pasture varieties in the Lake Grace area, as a result of interest from the LIFT group, in particular the host farmer, Royce Taylor. The original aims were:

1. To determine the impact of early sowing and later sowing on legume nitrogen (N) fixation for subsequent crops.
2. Determine the difference in nitrogen production and animal production of alternative legumes and sowing times.
3. Determine varieties which have tolerance to sulfonylurea (SU) herbicides due to the presence of prickly saltwort in the area.

By investigating these aims, farmers were hoping to identify a 'best bet performer' pasture, which would improve their systems and increase the value of their pastures to both the cropping and livestock enterprises. Improved pastures should mean less nitrogen, pasture re-sowing and feed costs, increased livestock condition, stocking rates and reproductive rates, as well as pasture that could resist necessary SU sprays when dealing with weed issues.

The results were not conclusive however there were indications that sub clovers and biserrula are best suited to the Lakes Information and Farming Technology (LIFT) group area. The site showed that there was little difference in soil nitrogen fixation across the 11 different treatments and therefore the focus of pastures should be for livestock feed, with nitrogen benefiting the following crop simply an added bonus. However, there was a positive link between crop tissue nitrogen and the previous year's pasture biomass. The project failed to investigate the impact of various sowing times, of tolerance to SU herbicides, due to false breaks, and an absence of prickly saltwort on site.

The project was initially run by grower participants, however midway through, it was identified that a coordinator was required to improve the management of the site. This led to a facilitator being bought on board, from which the group found great value. Participants also found value in learning feed quality and quantity measurement techniques as well as legume nodulation scoring, and how these could be applied to their pasture management. Other benefits included the sharing of ideas and practices during the project, which has opened communication channels with the district, not just about pasture management but wider farming practices. The group is interested in conducting further research into pastures most suited to their area.

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1 Background

The Lakes Information & Farming Technology group (LIFT) formed in 2010, in the Lake Grace area of the W.A. Wheatbelt. It was created to address gaps in localised agricultural research focussing on cropping systems. It also aims to provide a farming network to coordinate community farming projects and activities. The close-knit group of 17 core members is most interested in mixed farming, soil health addressing non-wetting soils, frost and climate variability, and adapting farming systems to face these challenges. Previous activities include mouldboard plough sites, succession planning workshops and frost and Sakura herbicide trials.

As mixed farmers, the group were interested to see if their pasture rotation for livestock could positively impact the following crop's nutrition, while providing quality feed for their sheep. Pastures are a vital part of mixed farming systems, impacting productivity and profitability, but can also be expensive to establish. Legume pasture species not only provide a high quality feed for livestock, but also benefit soil health through nitrogen fixation. This can lead to the decreased need of nitrogen fertilisers in the cropping system, cutting costs and improving soil fertility naturally. Having pastures in cropping rotation can also be a very effective break crop, controlling weeds and disease, while providing quality feed to livestock.

It is important to consider the pastures' suitability, in regards to:

- Land type
- Climate, especially frost, temperatures and rainfall
- Soil health and type
- Best sowing method
- Current and future land use
- Purpose - grazing or nitrogen fixation

Having such a wide range of pasture legume varieties available and having variable enterprises, producers have found it difficult to select the pasture best suited to their area. This need to quantify the suitability and benefits of legume pastures in their local area is what has motivated the LIFT group to conduct this trial. The pasture preferred by the host farmer was a mixture of three spineless burr medics; Serena, Circle Valley and Sandiego. He also grew Casbah biserrula successfully, but the most common pasture in the area is sub clovers.

The aim of this research trial was to analyse the performance of different pasture legumes in a mixed farming enterprise within the Lake Grace region. This was in regards to the impact of residual nitrogen levels on the cropping phase and value of pasture feed to livestock. Different hard seeded legume varieties were trialled to determine which are best suited to the Lakes area, benefitting livestock and cropping systems, as well as being easily harvested. Summer sowing of hard seed will be compared to late sowing with scarified seed in order to determine the area's optimal sowing time.

2 Projective Objectives

By 14 August 2017, have:

1. Determined the impact of early sowing and later sowing on legume production for nitrogen fixation for subsequent crops.
   - This objective was removed due to lack of seed availability and false breaks, as further explained in 4.3.1.
2. Determined the difference in nitrogen production and animal production of alternative legumes and sowing times.
3. Determined varieties which have tolerance to sulfonylurea (SU) herbicides.
   - This objective was removed due to an absence of prickly saltwort, and further explained in 4.3.1

3 Methodology

3.1 Research Sites

The research site was selected to represent typical conditions in the area, owned by one of the core members of the group, Royce Taylor. It was in a central location where other group members could reach easily in order to view the trial. It is a Mallee zone with mainly shallow topsoil over pale clay, interspersed by chains of salt lakes (Sawkins, 2011). The area receives an average of 340mm rain annually, with summer temperatures of 31 degrees Celsius and winter lows of 5 degrees Celsius. (www.bom.gov.au).

Soil tests were carried out on the chosen site to test for any limiting factors that may affect results.

3.2 Treatments

A total of 33 plots were involved in the trial, with three replicates each for the following pasture treatments. This layout is demonstrated in Appendix 1.

- Control – left completely
- Cadiz French serradella
- Control Fallow – sprayed out bare
- Bartolo Bladder clover
- Margurita French serradella
- Angel Medic sub-clover
- Fertiliser only
- Casbah biserrula
- Dalkeith sub-clover
- Izmir sub-clover
- Farmer Mix (three spineless burr medics; Serena, Circle valley and Santiago)

In autumn 2014, the plots were marked out, with the layout demonstrated in Appendix 1. Soil tests were carried out to get a base soil nitrogen level and a 40ft air seeder used to sow plots (40ft wide) over a length of 200m. Seeding was carried out as per the normal farmer practice for the area. All

varieties were sown with the recommended inoculant and with a base rate of fertiliser (50kgs/ha CSBP double phosphorous as per farmer standard practice).

- Margurita serradella pod and unscarified Bartolo bladder clover seed was sown in early March.
- Izmir sub-clover, Dalkeith sub-clover, Angel medic, Casbah biserrula, Cadiz serradella and the farmer mix was sown dry in April.

Pasture cuts were planned for six weeks after germination, and in the spring (October), to analyse each plot for quantity and quality of feed available for livestock.

In spring, whole plant samples from each plot were sent to John Howieson of Murdoch University in the first year of the trial. This was to analyse nodulation and whole plant weight, however, after delays in the first year's results, the farmers conducting this themselves in the third year of the trial.

Further soil samples were taken just before seeding in year 2, in order to analyse the amount of nitrogen available to a following crop in each plot.

In 2015, the second year of the trial, the plots were all sown over with wheat in order to analyse the impact of each legume on a following crop. Immediately prior to seeding, the site was sprayed with a knockdown and residual herbicide. Mace wheat was seeded at 70kg/ha with Mallee Extra fertilizer (CSBP) at 60 kg/ha.

The crop was tissue tested in each plot in September. Samples were sent to Jeremy Lemon of the Department of Agriculture, who analysed the relationship between wheat crop tissue N percentage and the previous year legume biomass, plant weight and nodule score.

The wheat was harvested when ready, using the farm's normal harvest practices. Total grain from each strip was weighed on a DAFWA weigh trailer to assess yield and samples from each plot were analysed for quality at CBH.

A further site was sown with the most successful legumes from year 1, to be left in the two remaining years of the trial, for further observation. Unfortunately, due to multiple false breaks in this season the seed failed to germinate and or died.

In the third year of the trial, 2016, the plots were left to regenerate with the original legume species. Pasture cuts were taken 6 weeks after germination and in the spring, to be analysed for pasture quantity and quality. Percentage germination of the target legume species was also visually analysed 6 weeks after germination, to record how well the target legume was able to regenerate and compete against weeds.

Root nodules were also analysed in spring by the LIFT group, assisted by consultant Ed Riggall. Soil tests were taken to 10cm depth in March 2017, to measure the ammonium N and nitrate N available to a following crop. A core was taken from each plot, then mixed with the other 2 repeats. A 100g sample was taken from each of the 11 combined samples and sent for analysis, looking at soil ammonium and nitrate levels, as well as organic carbon, pH and other indicators of soil health.

The trial was essentially split into the following three experiments.

Experiment 1: Comparison of hard-seeded legume varieties

1. 2014, pasture cuts taken from quadrats six weeks after germination and again in spring to compare feed on offer (FOO) between the varieties
2. Whole plant samples collected and sent to the Centre for Rhizobium Studies at Murdoch University for analysis of rhizobia strain within the nodule and an interpretation of amount of N fixation.
3. Soil nitrogen tests taken to compare between legume species, along with GreenSeeker measurements.
4. Legume regeneration assessed by observing germination rates. Photos taken and a percentage cover estimated.

Experiment 2: Summer sowing of hard seeded legumes vs April (dry) sowing with scarified seed

Pasture cuts taken from quadrats 6 weeks after germination and again in spring to compare kg/ha of FOO between the varieties and allow comparisons in feed available at the start of the season which is the most critical time for filling feed gaps. Spring cuts determine whether sowing date still has an influence later in the season or whether growth is independent of sowing date.

Experiment 3: Best performing legume pastures

A new trial site established to further investigate the 'best performers', the legumes analysed to have performed best in year 1. This was to run for the remaining 2 years of the trial, looking at food on offer (FOO), nodulation, N fixation and legume regeneration in subsequent years after establishment.

3.3 Statistical analysis

In 2014, the legume plots were compared for feed quantity and quality; to see the ability of each legume pasture to produce appropriate sheep feed. When it became impractical to use pasture cut analysis due to livestock grazing, visual observations were made, considering livestock preferences as well as germination results.

Legume nodulation was scored and soil samples taken, to be compared between plots.

In 2015, wheat tissue samples were analysed for N percentage. The results were compared between plots and also to the previous year's legume biomass, plant weight and nodule score, to test for relationship between legume biomass in year 1 and the subsequent wheat tissue N in year 2. Harvest yields and quality results were compared between sites and repeats of the same legume were compared using Genstat software, to analyse variation, therefore value of results.

In 2016, pasture legume quantity was compared between plots and to the equivalent results in 2014. Percentage germination and root nodulation was compared between plots.

Soil ammonium N and nitrate N was compared between varieties and also between repeats, to test for variation.

3.4 Extension and Communication

The LIFT group was invited to participate in the activities surrounding the trial whenever possible, to give them a hands-on learning experience. Combined with the bi-annual field days (open to non-members too), this enabled them to view the project's progress and pitfalls themselves, as well as discuss the results and future plans. The field days were also designed to prompt discussion on the role of legume pastures on mixed properties, and create enduring relationships to continue the exchange of ideas.

During the first year of the trial, an article about the project, in the Group newsletter, was sent to 65 members. Interest in this article led 31 people to attend the first field-walk. This was to observe the legume strips and discuss results so far, and included farmers, agronomists (private & commercial), DAFWA and NRM officers. The field walk was well received and resulted in a request from the Nyabing Farm Improvement Group to be included in the dissemination of results. A further field day was organised a month later for this group and other interested parties to attend.

In the second year of the trial an update on results was written up and published in the 'Lakes Link', sent to group members. A field walk was planned for September, but was not carried out due to the lack of visual evidence. This was due to all strips being sown with wheat on the main experiment site, and the false break caused a failure in establishment on the new site of the best legumes. However, members of the LIFT group did attend other field walks for different group's trials.

In the final year of the trial, four members of the LIFT group attended a field walk in July, to observe the legume regeneration following a wheat crop and discuss harvest results from the previous year. There was minimum growth or variation at this stage, the group were able to visually determine germination of the target legumes and samples were dug up in order to look at nodulation. At the next field walk, in October, attendees viewed how the plots had progressed and discussed results, as well as taking FOO measurements and pasture cuts. An article was also written and emailed out to LIFT and the Nyabing group members, so that those who were unable to attend the field walk were kept up to date.

4 Results & Discussion

4.1 Measured trial results

4.1.1 2014 Results

Initial soil tests on the trial site showed no limiting factors, although the soil pH (CaCl2) within the "South" sample site was marginal at 4.8-4.9 (raw data found in the metadata).

- "Summer sown" Margurita french serradella pods, unscarified Bartolo bladder clover and Cadiz serradella were sown 28/3/2014.
- The Margurita French Serradella and Bartolo bladder clover seed were not available from the seed supplier in early March (as planned) so the sowing date was delayed until the 28th of March.

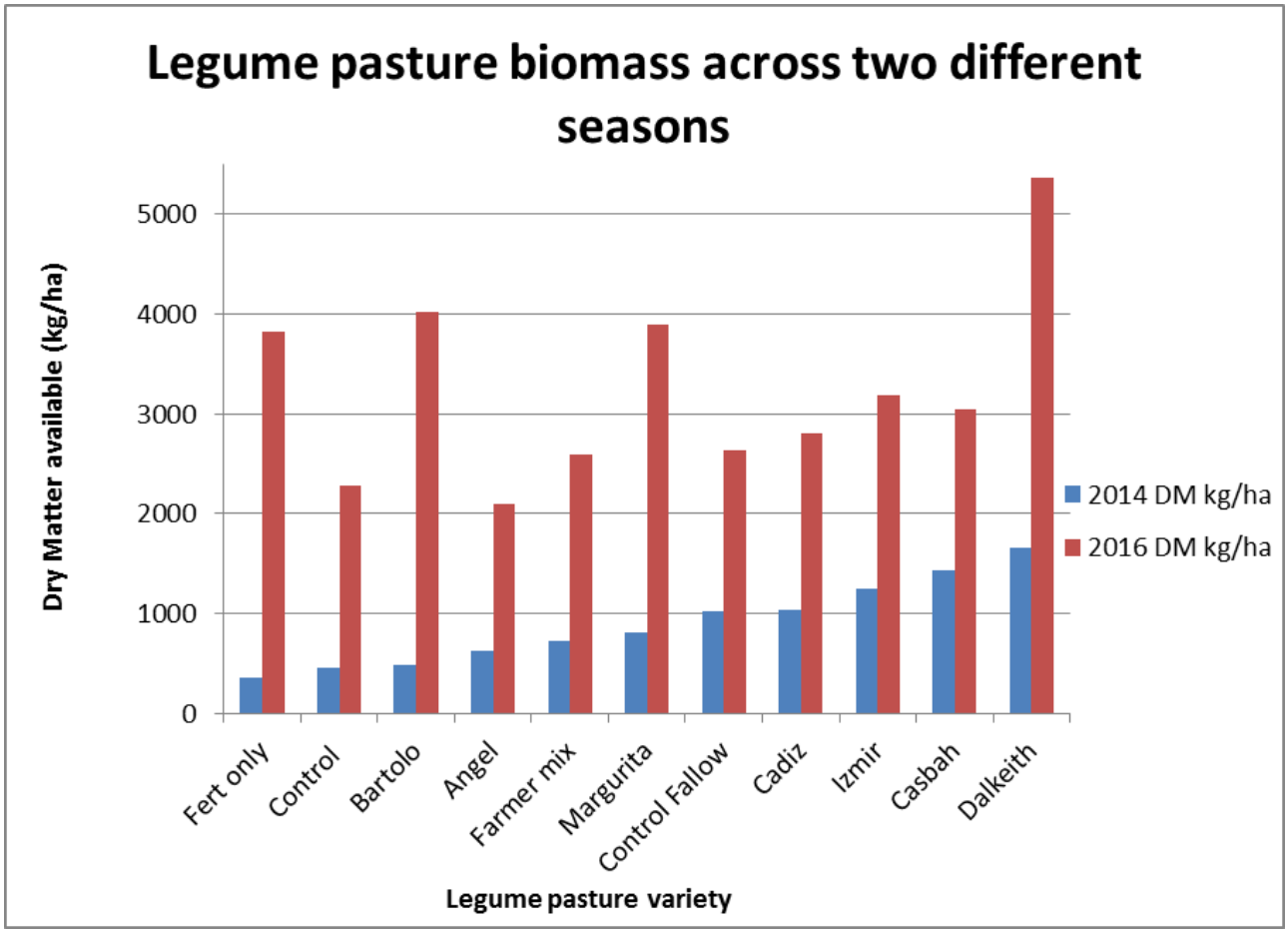
- The Cadiz Serradella was thought to be a hard seeded variety so was sown early, however this was a mistake as Cadiz is predominantly a soft-seeded variety.
- The host farmer Royce Taylor's mix of Serena/Sandiago/Circle Valley was sown mid April.

The remainder of "April (dry) sowing" varieties were sown 24/4/14; Izmir sub clover, Dalkeith sub, Angel medic (SU herbicide tolerant) and Casbah biserrula. Even though some rainfall was recorded on the 9th of April, by the time the April dry-sowing was completed the top 10 centimetres of the soil profile was dry. As pasture seed is only "scratched" in then there would have been no contact with any stored soil moisture. If these varieties had been sown prior to the 9th April rain then we could have had a patchy or staggered germination, or being a false break the varieties could have germinated then died before the next rain event.

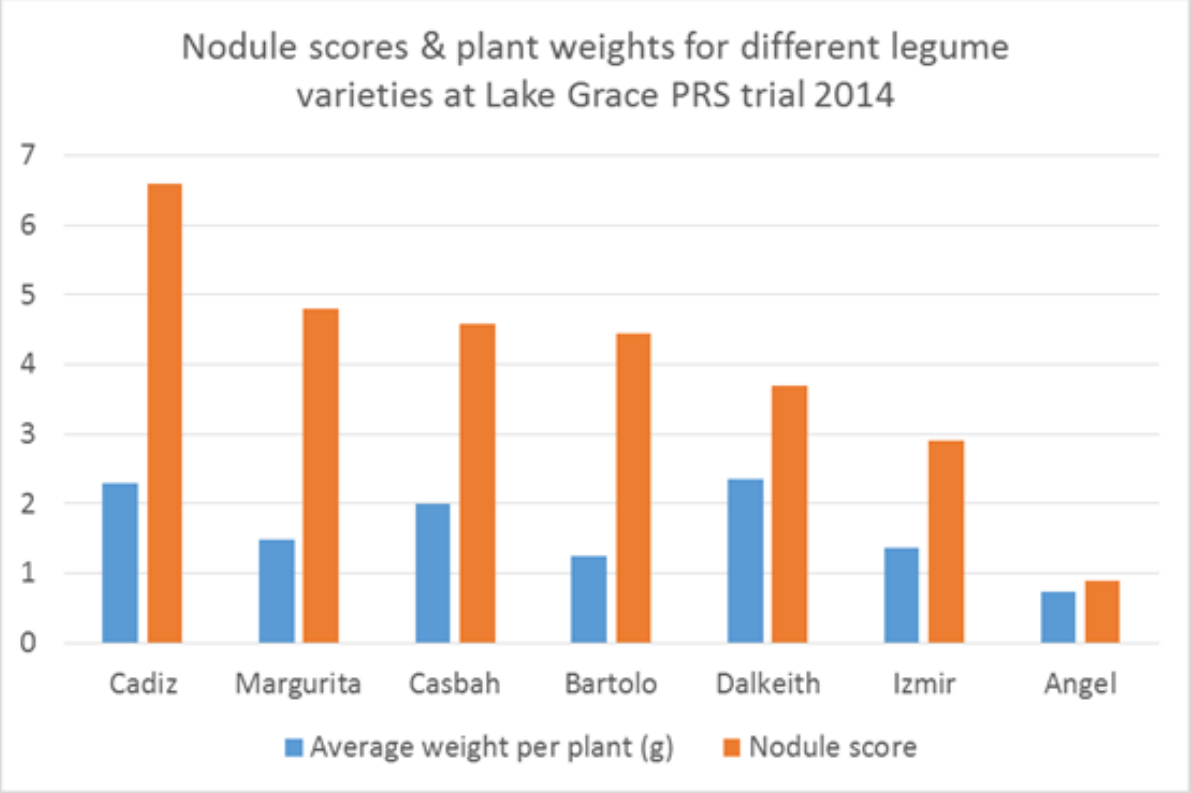
All of the strips eventually germinated and established well. Pasture cuts were not taken 6 weeks after germination because heavy grazing would have skewed results. However, visual observations were taken that Margurita french serradella, Casbah biserrula and Cadiz french serradella varieties were preferred by the sheep, being grazed most heavily in the beginning. This was presumably because these varieties were easier to graze, standing erect compared with the more prostrate clovers. As the strips grew, clover became more heavily grazed as they became easier to graze. The biserrula became the least palatable strip by spring, when it was clear that the sheep grazed around the strip but hardly touched the biserrulas. This could have influenced the dry matter results of Graph 1, taken in spring.

Pasture cuts, as shown in Graph 1, were taken in years 1 and 3 of the project. However, the cuts were taken only ten days post grazing, so feed quantity results may have been skewed by preferential grazing. While the biomass follows similar trends across the two years, there are not only increases in FOO, but also variation in the best performing pasture in years with different rainfalls. The 2014 dry matter levels showed that the sub clovers, Izmir and Dalkeith, and the serradellas, Casbah and Cadiz, had the highest DM kg/ha. 2016 showed similar patterns, with Dalkeith sub clover and Bartolo bladder clover had the highest biomass. However, Bartolo was the lowest performing variety in 2014, with Angel medic had the lowest DM in 2016, being the worst performer DM wise over the trial. The variation in the Bartolo DM over the two years indicates that there were uncontrolled variables at play, such as rainfall, and that the legume pastures will perform differently under different conditions.

It is interesting that the varieties with the highest DM/ha did not necessarily have the highest weight per plant (as shown in Graph 2).



Graph1: Legume pasture dry matter measurements over two different seasons, one average and one wet.



Graph 2 – Nodule Scores and Plant Weights for Different Legume Varieties

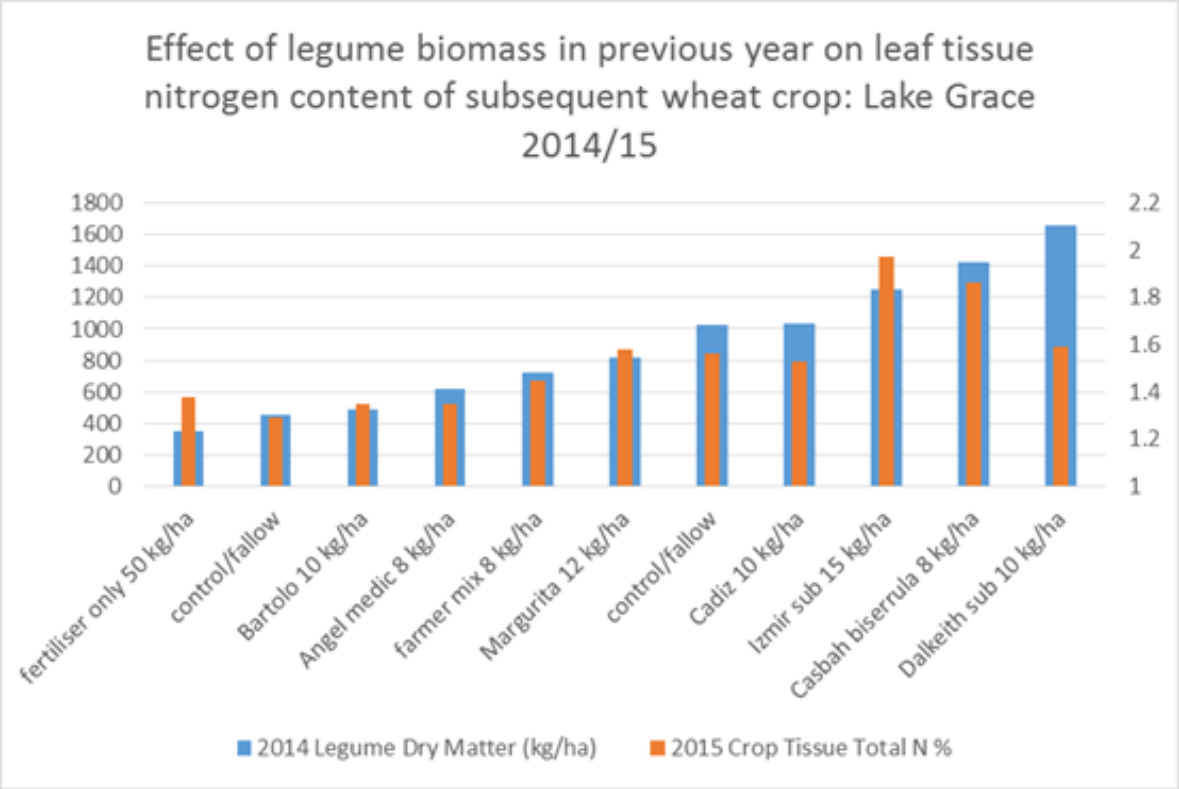
Cadiz serradella showed the highest level of nodulation, followed by another serradella, the Margurita. In comparison, the sub clover Dalkeith had the highest average weight per plant, followed by Cadiz, then Casbah biserrula. This is interesting as the Casbah also had the third highest nodule score, making Casbah the best overall performers in regards to nodulation, plant biomass and plant weight. There did not seem to be a relationship between nodule scores and plant biomass, nor dry matter production per ha.

4.1.2 2015 Results

This second year of the trial indented to further investigate different pasture legume's performance. A new trial site was established, sowing the 'best performers'- legumes analysed to have performed best in year 1. This was to run for the remaining 2 years of the trial, looking at FOO, nodulation, N fixation for future cropping, legume regeneration in years after seeding. Multiple false breaks led to this aspect of the trial being abandoned, as the pastures died too late in the season for successful re-sowing to occur.

Mace wheat was successfully established over the legume pasture site sown in 2014. An attempt was made to establish the most favoured legumes on a different site (experiment 3), but these failed to established due to patchy rain and this part of the trial was abandoned as a result.

Graph 3 shows that there was a positive relationship between wheat's tissue nitrogen and the previous year's legume biomass. There did not appear to be any relationship between wheat nitrogen levels and nodule score.



Graph 3 – Effect of Legume Biomass in 2014 on Leaf Tissue Nitrogen Content of Wheat Crop in 2015

When plotted against each other, above-ground legume biomass in 2014, and the leaf tissue N content of the wheat crop in 2015 have a correlation coefficient (r2) of 0.6, meaning that 60% of the variation in crop tissue N % can be explained by legume biomass from the previous year. In contrast, there appeared to be absolutely no relationship between the nodule scores or plant weights of legumes in 2014 and the crop tissue N content in 2015 (r2 = 0.007, 0.096 respectively).

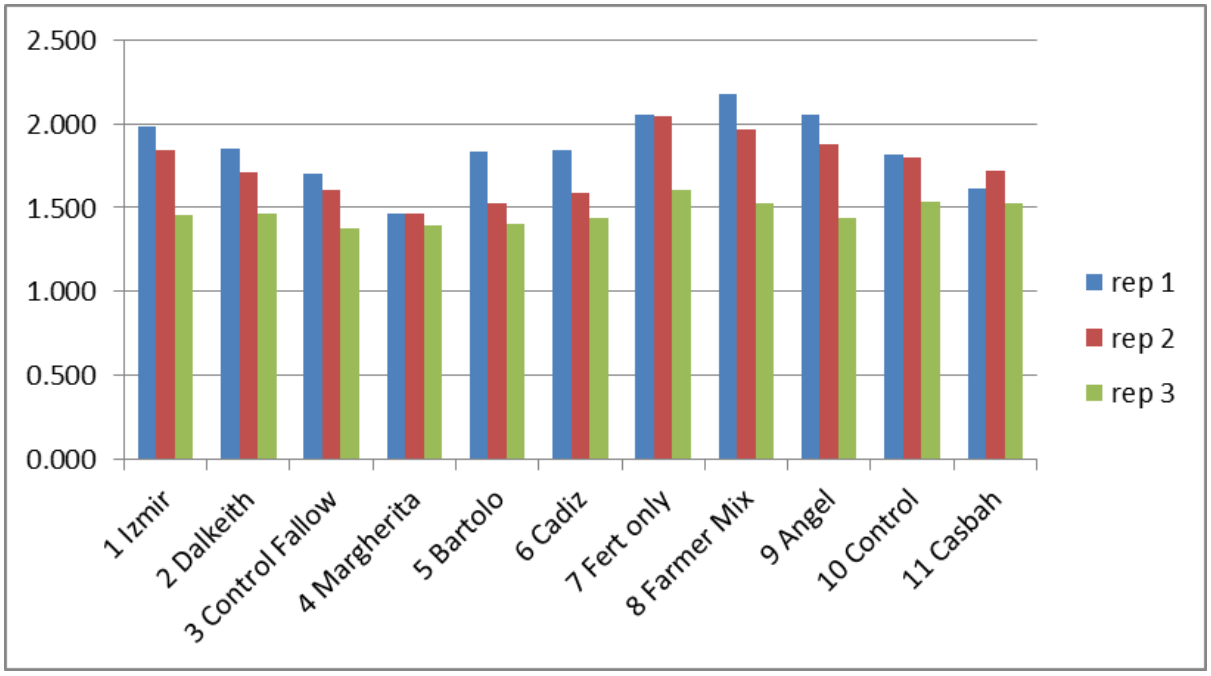
As shown in Table 1, the highest yield of 1.9t/ha came from the fertiliser only plot, with the control outperforming 6 of the other pasture treatments, followed by the farmer mix, 1.89t/ha. There was a significant gap (0.1t/ha) then the Angel medic sub clover at 1.79t/ha, followed by Izmir at 1.76t/ha. The farmer mix had the highest protein levels, followed by the Izmir and Dalkeith sub clovers, then the Casbah biserrula. The Izmir also had the highest hectolitre weight, followed by the control fallow, then Dalkeith and the fertiliser only treatment. Lowest screening percentages were also found in the Izmir and control fallow at 1.7%, followed by the Dalkeith, Angel medic sub clover and the control treatment at 1.9%.

Table 1 – 2015 Average Wheat Yield and Quality following Various Pasture Crops

Previous Crop	Grain yield t/ha	Protein %	Hectolitre weight kg/HL	Screens %
Izmir sub-clover	1.76	9.1	79.3	1.7
Dalkeith sub-clover	1.68	9.0	79.1	1.9
Control Fallow - sprayed out bare	1.56	8.6	79.2	1.7
Margurita French serradella	1.44	8.7	78.7	2.4
Bartolo bladder clover	1.59	8.7	78.9	2.0
Cadiz French serradella	1.62	8.6	78.7	2.4
Fertiliser only	1.90	8.7	79.1	2.1
Farmer Mix [A]	1.89	9.4	78.9	2.0
Angel Medic sub-clover	1.79	8.7	78.7	1.9
Control - left completely	1.72	8.2	78.9	1.9
Casbah biserrula	1.62	8.9	77.8	3.0

[A] Farmer mix is a mixture of the three spineless burr medics; serena, santiago and circle valley.

Graph 4 highlights how the harvest results do not show any clear trends, across or between treatments. Analysis using Genstat software confirmed this, showing as much variation between replicates as between treatments. This gives an indication of the differences in the plot replicates, as replicate 1 had consistently higher yields than replicate 2, which on average also had higher yields than replicate 3's treatments. Replicate 2 and 3's results are more similar than 1's. The wheat crop was not sprayed with strips of Flexi-N, so there are no GreenSeeker or tissue test results.



Graph 4 – Wheat Yield of individual plots following Various Pasture Crops

4.1.3 2016 Results

The scheduled pasture cuts 6 weeks after germination were not taken, as the fence to prevent grazing had not been erected. However, germination was visually assessed, as well as nodulation scoring and photographs of each plot were taken, as shown in Appendix 2.

biserrula had the highest germination rate, followed by clovers with a good germination rate, and the serradellas having sparse regermination after the year in crop. Nodulation showed opposite results to germination, with the serradellas showing very good levels of nodulation compared to the biserrula having lots of tiny nodules. The clover again performed well with good nodulation.

On 7th July, a strip of flexi N was applied to all of the legume strips, at a rate of 100L/ha. This had no visible effect on growth or health of the plants, as shown in Image 1, nor was it visually detectable at the visit on 13th October.

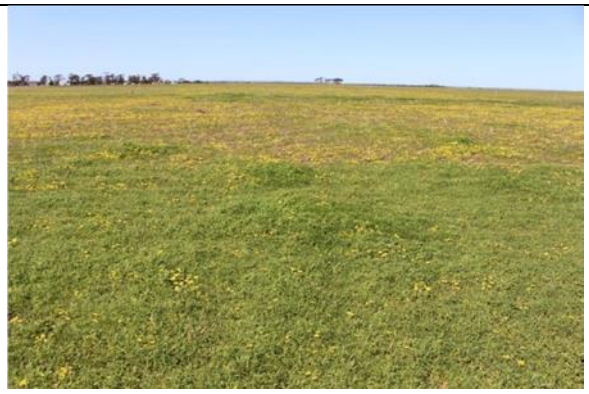
Dalkeith sub-clover had regenerated best, and had higher dry matter/ha, or FOO, compared with the other treatments (as also found in 2014). This was followed by the Bartolo bladder clover, Margurita French serradella and fertiliser only treatment, which had FOO values of approximately 80% of the Dalkeith. The biserrula had the best overall cover percentages, and the control strips were generally sparser than the legume strips. An aerial photograph taken the same day as the pasture cuts shows this visually, as shown in Image 2.

Most of the pasture had died or begun to die by the date of the spring pasture cuts, as shown in the photographs in Image 1 and 2. This made it difficult to accurately take the cuts, as the vegetation was desiccated and disintegrated when touched, and was at risk of blowing away.

The serradellas remained green for the longest (Image 2) so could be a valuable source of vitamin E for sheep (especially early lamb weaners) when most other green feed is gone at the end of season. However, serradellas are hard seeded, so germinates more slowly than the other legumes, shown by the difference in percentage cover in October compared with July. This slow germination enables weed species to gain a competitive advantage, as occurred during the trial.

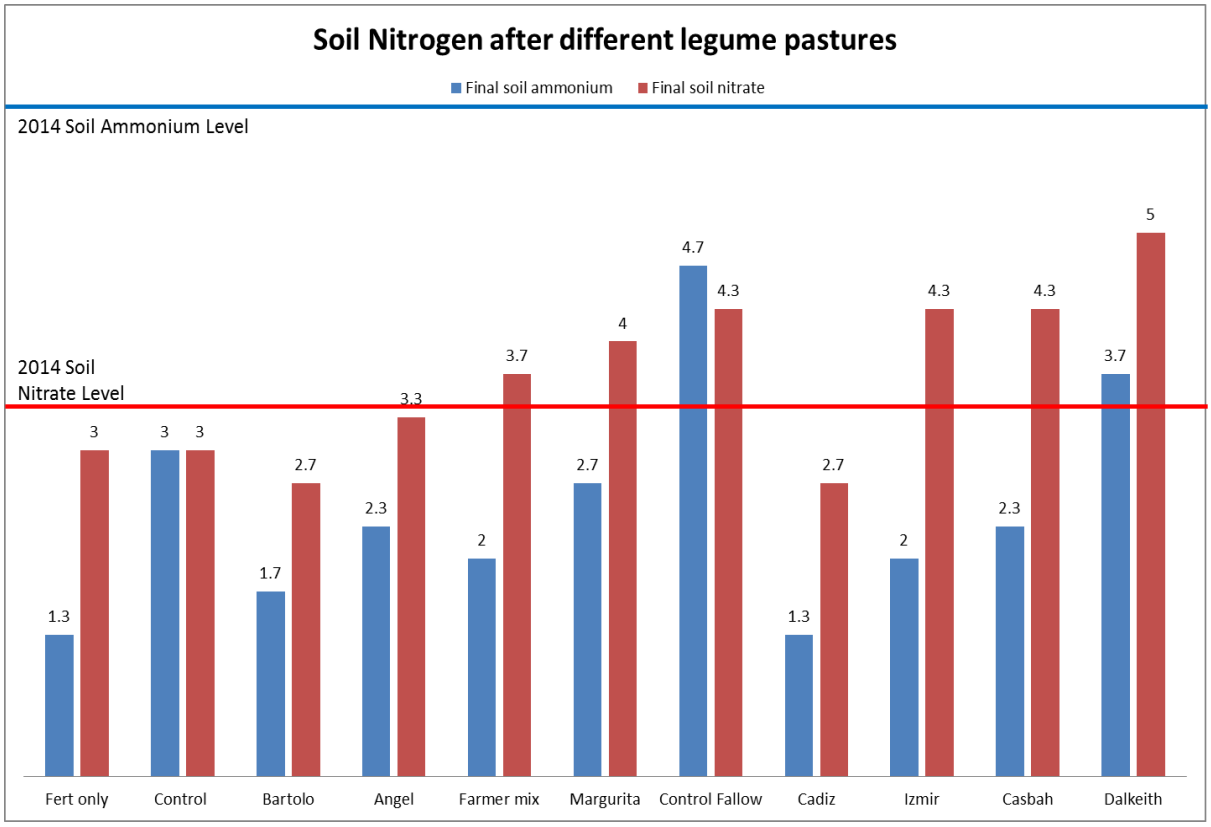
Pasture cuts were taken in spring and a visual estimation of the percentage cover of the target legume was made, shown in Appendix 3.

Image 1 – Nitrogen Rich Strip, photographed in late September 2016



Nitrogen rich strip, with no visible signs (late September 2016). The strip goes away from the camera as the photo has been taken. The horizontal variation on the photographs is the different legume strips.

Image 2– Aerial Photograph of Legume strips, taken on same day as Spring Pasture Cuts.



Graph 5- Soil nitrogen levels before and after legume and wheat rotations.

Soil samples, taken in March 2017, showed fairly considerable variation between repeat plots, which suggests that factors other than the last year of legumes influenced the results. The average soil nitrogen results in Graph 5 showed that soil nitrate and ammonium were lower after the trial compared to the initial measurements taken prior to seeding in year 1. These are essentially the amounts available to any crop grown in the following year. Margurita French serradella showed the highest ammonium nitrogen levels, but also a high level of variation. Both control plots also showed high ammonium N levels, suggesting that the legumes were not entirely responsible. Nitrate N levels showed less variation between legumes and between repeats, suggesting higher accuracy in measurements. Dalkeith sub-clover showed the highest reading but both control plots also showed relatively high amounts. While the graph shows that nitrate levels were improved by the legume pastures, the 2016 soil ammonium levels are significantly lower than the initial 2014 measurements. This could be due to nitrogen being removed by the crop and legumes or leaching across and down the soil profile. The paddock had also been in crop prior to the beginning of the trial, so soil nitrogen could already be at low levels. More trials are required to make any conclusions, however the farmers interpreted these results as variety not having a significant enough of an impact on soil nitrogen to take into account when selecting a legume pasture variety.

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4.2 The value of the research results (Benefits/Costs)

The original project objectives had to be amended, due to constant challenges in the research design, as explained in 4.3.1. This means that the results are not as extensive as planned. However, the results did show the sub clovers seem to be best suited to the Lakes area, and that medics are too fragile for the soil type. The results also indicated that there are not hugely significant differences in the nitrogen fixating ability of different legumes that would justify selecting a variety for its benefit to the crop, compared to its value as a livestock feed. This highlighted that the main role of pastures is for stock, and nitrogen for the cropping phase of mixed farms is an added bonus. In saying this, there was a positive relationship between legume biomass and crop nitrogen which could be exploited on farm to produce more profitable pastures and crops.

The results clearly showed that legume pasture variety selection plays a huge role in determining pasture quality and quantity, and that this simple choice can significantly increase on-farm feed, leading to higher stocking rates in spring, higher lamb survival rates and sheep in better condition. Farmers saw that biserrula's are best at germinating, but for a regenerating pasture, Dalkeith sub clover is the best choice. This result can be adapted and applied on farm to reduce the amount of re-sowing required over the years. Further research would give more reliable results as to the savings in nitrogen by using Dalkeith, with its higher soil N fixation, and benefits to livestock, feeding and stocking rates through higher quality and quantity of feed.

With SU herbicides not being applied, the objective of testing pasture varieties for SU tolerance had to be adjusted. If SU herbicides had been required, it is expected that Angel medic would have performed better than other varieties, a value of Angel medic not reflected in this project's results. As an aside it should be noted that SU's were used consistently during the paddocks rotations prior to the trial.

Through being involved with the project, the importance and value of using inoculant and correct application rates was reinforced to farmers. Correct rates will lead to better, more effective pasture management, germination and growth, potentially decreasing pasture failure and therefore overall costs.

Other benefits of the project outside of the direct research results are discussed in section 4.3.

4.3 Effectiveness of the Project

4.3.1 Outcomes in Achieving Objectives

The original project objectives were not met entirely, due to external issues that made it impossible to follow the proposed method, such as weather and miscommunications. However, conclusions beyond these initial objectives have been determined over the course of the trial.

Objective 1: Determine the impact of early sowing and later sowing on legume production for nitrogen fixation for subsequent crops:

The lack of availability of seed in year 1 of this trial, as well as incorrect information about seeding times and a false break prevented significant differences in sowing dates from taking place. The

failure of the 'best performers' part of the trial in year 2 meant that a second chance at this question was thwarted.

Objective 2: Determine the difference in nitrogen production and animal production of alternative legumes and sowing times:

This objective was properly examined, with 60% of the variation in crop tissue N % could be explained by legume biomass from the previous year. However, there was no relationship between the nodule scores or plant weights of legumes in 2014 and the crop tissue N content in 2015. These results require further repetition before they can be qualified as accurate.

Soil N, after the 2016 pasture season, was tested. Results showed variation between repeats and the control plots showed high N levels, both for ammonium N and nitrate N, suggesting that factors other than the legume root nodules had affected results, including percentage cover of the target legume. In addition, the soil nitrate and ammonium levels were lower than those recorded before the trial. Further repetition would need to be carried out before accurate results could be analysed.

The quantity and quality of legumes in years 1 and 3 were tested, but not to the extent that was anticipated, due to livestock grazing and early desiccation of the plants. The spring cuts in both years showed similar patterns. Most interestingly was Dalkeith sub-clover consistently showed the highest dry matter, which also corresponded to the highest crop tissue N in year two.

Further investigation, and modelling of outcomes in animal systems, would enable more reliable and valid results. However, from this project, the LIFT group has deducted that the priority of pastures is sheep feed, with the nitrogen fixations impact on future crops a bonus side-product.

Overall, the group believes there was indication of potential best performers in Dalkeith sub clover and the biserrula, and that sub-clovers are better suited to their area than medics, which farmers believed were fragile in that area. Izmir and Dalkeith sub clovers, followed by Casbah biserrula showed the highest dry matter content, with biserrula germinating most successfully and the Dalkeith sub-clover regenerating best.

Objective 3: Determine varieties which have tolerance to sulfonylurea (SU) herbicides:-

This objective was not tested, as SU spraying was not required due to the absence of prickly saltwort. It should be noted again

that SU herbicides were used extensively on the trial site(in crop) prior to when the trial began. Thus, in effect if there is a residual effect of SU chemicals on legume pastures following crop this would have been observed.

A nitrogen application was tested in year 3 of the trial, as requested by the farmer group. This showed no visually detectable results.

4.3.2 Participant Reactions

Participation in field walks and continual producer feedback showed that there is interest in the results, and how to adapt the findings to individual farms.

The trial introduced some new legume options to the farmers and some of the results, particularly regeneration and feed quality surprised them, leading to consideration of other options for their own pastures. Others were more confident in their own pasture variety selections (mostly those using biserrula and sub clovers) after the project, while a group also want to investigate the suitability of serradella's on the Lakes areas' sandier soils. The use of the inoculant sparked discussion and some farmers have decided to use inoculants on their own farms.

The skill of calculating feed on offer (FOO), as well as nodule scoring, was discussed and taught/demonstrated at field days. Farmers commented that they would be better able to calculate feed available for their livestock, which will help them to be more efficient in rotating livestock and know the required supplementary feed. Participants also found value in being involved with trial methodology and setup. From the issues faced throughout the project, they learnt that field scale research is reliant on favourable conditions, which are unpredictable, and hence why it is difficult for the industry to provide farmers with reliable and valid research results.

More evidence would be required for farmers to make decisions regarding time of sowing and N production for following crops, but they were interested in looking at root nodules, understanding how N-fixation works, and how farmers can better monitor their pastures. In addition, wanting to do further repeat trials, in order to gain more valid and reliable results, there is also interest in investigating other aspects of pastures, such as the influence of inoculants, suitability of serradella on sandy soils, and nitrogen applications.

Overall, the LIFT core members stated that based on the discrepancies in the nitrogen data, "sheep feed is the priority for pasture, and the nitrogen is an added bonus". Another participant highlighted the importance of the trial, stating that "pasture drives everything" and that it is more efficient to "grow more than hand feed". It was widely agreed that the project added great value to LIFT, Nyabing Farm Improvement Group and other producers involved, not only through the research results: "*making us all think about our pastures and filling the feed gap*" and skills gained, but also in producer/industry interactions, and discussions about general farming issues.

4.3.3 Producer Research Site Program & Extension and Communication

The core producer group was an enthusiastic, innovative group, interested how the results of this project would influence their pasture selection and management. This is one of the key attributes that made the group work. However, during busy times of the year, the demonstration site activities fell by the wayside, due to lack of clear communication between members about responsibilities. The group solved this issue by bringing in a facilitator, which not only helped streamline their ideas, but began constant communication on "WhatsApp". This led to the project being back on track, as enthusiasm had waned as results were unclear and aspects of the trial failed due to false breaks. The

group agreed that this was an excellent decision, and any future projects will involve a facilitator to ensure projects are worthwhile: "*we will get someone involved early rather than just do it ourselves*".

Producers and industry were engaged through newsletters, field days and communication through existing group networks. A summary of extension and communication activities can be seen in Table 2.

Table 2: Main Extension and Communication activities conducted during the project

Date	**Activity**	**Number of people**
August 2014	Article in Group newsletter	Sent to 65 members of LIFT group.
20th August 2014	Field-walk, to observe the legume strips and discuss results so far	31 attendees, incl. farmers, agronomists (private & commercial), DAFWA, NRM
17th September 2014	Field walk to observe legume strips again and discuss results so far.	Nyabing Farm Improvement Group & LIFT members
August 2015	Article in Lakes Link	Sent to members of group (65)
August 2015	LIFT group members attended field walks on other trial sites funded by MLA.	Open to all 65 LIFT group members.
September 2015	LIFT group field walk cancelled due to lack of difference in trial to view.	N/A
July 2016	Field walk to observe regeneration of legumes following wheat crop and discuss the previous year's harvest results.	Open to all 65 members of the LIFT Group. 6 Attended
October 2016	Field walk to observe how well the legumes had progressed and discuss results.	Open to all 65 members of the LIFT group. 8 attendees
October 2016	Article emailed out giving the results of the trial up to this point.	Emailed to all 65 members of LIFT group.

The trial could not be changed significantly after the legumes were first sown, as they were then monitored for the three years. The selection of the 11 species was done by the group, based on what was currently being used in the district and varieties said to perform well in similar conditions. The host farmer has considerable influence, particularly by including his own mix.

After the failure of the 'best performers' part of the trial, and unclear results, the farmer group wanted to add further value to the project. They were eager to trial the variable, nitrogen applications during the final year, as a way of evaluating the value of nitrogen provided by the legumes and show how worthwhile N applications, which constitute a large proportion of their input costs, really are.

5 Conclusions/ Key Messages /Recommendations

Although project objectives were had to be adjusted, the trial was successful in raising awareness about the different legumes available for farmers, how well they grow in the Lakes area and the potential value of legumes to future crops, in terms of nitrogen fixation. An understanding of the principles of nitrogen fixation, a consideration of feed value to livestock and the notion of the influence on future years when deciding upon paddock uses got farmers thinking, discussing options together and looking at existing research, which they are able to apply to their farm situations. As attendance numbers show, the trial sparked enthusiasm amongst local farmers, even attracting the attention of other grower groups. There is interest in future trials, perhaps investigating if serradellas are better suited to local sandy soils.

Members gained or improved the useful on-farm skill of pasture assessments for FOO. Another benefit of the trial is the immeasurable significance of open communication, with the exchange of ideas and experiences. The group found great value in learning about trial methodology and issues that arise when conducting open-field trials, as well as the value of using facilitators. There was also great interest in the use of inoculants, which may lead to more farmers better utilising them and improving their pastures. 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.

The research results highlighted the importance of selecting a suitable pasture, with a wide variance in pasture variety performance in the area, however, further investigation is required to support our findings. Results indicated that sub-clovers, followed by Biserrula, may be best suited to the Lakes area, in terms of feed quantity and quality, as well as germination and regeneration. When the farmers interpreted the results, they found the key finding to be that there are not hugely significant differences in the nitrogen fixing ability of different legumes that would justify selecting variety for its benefit to the crop, compared to its value as a livestock feed. The link between crop tissue nitrogen and previous year's legume biomass was another key finding that could be exploited for healthier crops, soils and lower nitrogen costs.

6 Bibliography

Sawkins, D N. (2011), Landscapes and soils of the Lake Grace district. Department of Agriculture and Food, Western Australia, Perth. Bulletin 4825.

7 Appendix

7.1 Appendix 1: Trial plot layout

LIFT Group Trial Layout

1 Izmir sub @ 15kg	12 Izmir	23 Izmir
2 Dalkeith sub @ 10kg	13 Dalkeith	24 Dalkeith
3 Control/fallow	14 Control	25 Control
4 Margurita @12 kg	15 Margurita	26 Margurita
5 Bartolo @ 10kg	16 Bartolo	27 Bartolo
6 Cadiz @ 10kg	17 Cadiz	28 Cadiz
7 Fertilizer only @ 50kg	18 Fert only	29 Fert only
8 Farmer mix @ 8kg	19 Farmer mix	30 Farmer mix
9 Angel medic @ 8kg	20 Angel	31 Angel
10 Control	21 Control	32 Control
11 Casbah @ 8kg	22 Casbah	33 Casbah

< NORTH

All varieties were seeded with 50 kg of CSBP double phos and Alosca

Rest of trial paddock seeded with the Farmer mix

7.2 Appendix 2– Description of Plots 05/07/2016

Strip Number	Legume sown in 2014	Comment on Germination etc	Comment on Nodulation	Photo (05/07/16)
1	Izmir	Good germination. Very dark green. Good growth	Good nodulation	
2	Dalkeith	Good germination and growth.	Good nodulation	
3	Control / fallow	Sparse cover including native clover, grass, cape weed		
4	Margurita French Serradella	Sparse germination of serredella but a lot of weeds.	Very good nodulation	

Appendix 2 continued

5	Bartolo bladder clover	Sparse germination of bladder clover but a lot of weeds.	Good nodulation	
6	Cadiz French serradella	Sparse germination of serreadella but lots of weeds	Very good nodulation	
7	Fertiliser only	Sparse growth of native clover, grass, cape weed		
8	Farmer mix	Quite good germination and growth	Poor nodulation	
9	Angel medic sub-clover	Good germination and growth.	Very poor nodulation at this stage	
10	Control / fallow	Sparse cover of native clover, grass, cape weed		
11	Casbah biserrula	Very good germination and growth. Not heavily grazed as un-palatable.	Small nodules but plentiful	

7.3 Appendix 3: Pasture Cuts, October 2016

Legume Sown 2014	Photo 13/10/16	Estimate of % target legume	Mean DM from 3 cuts (kg/ha)	Variation (average deviation from mean (kg/ha))
1. Izmir		90	3186.7	935.6
2. Dalkeith		90	5363.3	1037.8
3. Control / Fallow			2636.7	677.8
4. Margurita French Serredella		60	3896.7	597.8

5. Bartolo Bladder Clover		70	4023.3	568.9
6. Cadiz French serredella		20	2810.0	353.3
7. Fertiliser only			3820.0	380.0
8. Farmer mix		80	2596.7	1502.2

9. Angel Medic sub-clover		70	2100.0	246.7
10. Control / Fallow			2286.7	171.1
11. Casbah biserrula		99	3043.3	717.8

Appendix 4 General Photos

Pasture sampling 2014

Photos of Crop Tissue Testing, 9th September 2015

Harvesting The Trial Site December 2015

Photos from the Paddock Walk, 5th July 2016

LAKES INFORMATION & FARMING TECHNOLOGY (LIFT)
Spring Field Day
20th August 2014
9 am– 1pm

Itinerary for LIFT Spring Field Day :

Pasture Trial—MLA , at Royce Taylor's farm

Scope Barley—Royce Taylor

Yield Prophet Update– Keith Devenish, DAFWA

Intergrain Trials—Talk by Dave Meharry at Brad Watson's farm

Mae Connelly– Farmanco Grain Market Update

Lunch & Drinks provided by Sonia Carruthers of Emerald Grain.

Followed by Rabobank dinner & talk by Neil Townsend, Winnipeg, at the Lake Grace Hall, 6.30 pm. Contact Rabobank Lake Grace for further details.

Field Day RSVP: ***Lauren Duckworth, 0488 559 860 or Grant Marshall, 0429 649 030***

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