final report

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Good clover, bad clover

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Abstract

Oestrogenic clovers are problematic on properties in the South East of South Australia and Kangaroo Island. The project increased the awareness of producers to the presence of oestrogenic sub clovers present in their pastures and provided a measure of their severity and extent on property and across the districts.

As not all paddocks that contain oestrogenic clovers will be high risk, whole farm assessments are critical to form a sound management plan to manage infertility and health issues in sheep flocks. However, producers found undertaking visual risk assessments using the stick method to be difficult and time consuming. Assessments undertaken on approximately 100 paddocks across the South East and Kangaroo Island found 100% of paddocks had oestrogenic cultivars present with 69% of paddocks having greater than 30% oestrogenic clovers present in the clover proportion of the paddock, providing the potential to cause fertility issues in ewes.

91% of the core producers had adopted grazing management options and 55% had also adopted some pasture manipulation or renovation with 100% of core producers intending to adopt pasture renovation in future years.

Diluting the oestrogenic cultivars within a pasture by implementing agronomic, grazing and livestock management strategies can be an effective way of controlling the potential impacts on sheep flocks.

Executive summary

Annual subterranean clovers are a core base for many pastures in the medium to high rainfall areas of South Australia, including the South East and Kangaroo Island. In the 1960s or earlier, oestrogenic clovers became a major issue on many properties in South Australia (particularly Kangaroo Island where they were established after the WW2 Solider Settlement Scheme) causing severely low lambing percentages.

Extensive research was undertaken in the 1960s-1980s which is now outdated, and this research is not reaching the new generation of producers with key extension messages and skills vital in managing issues largely forgotten.

Over the years the focus on oestrogenic clovers has reduced and as verified by the work undertaken in this project high levels of oestrogenic clovers in pastures have built up, resulting in reduced lambing percentages and an increasing numbers of dry ewes impacting on the profitability of producers.

The 'Good Clover Bad Clover' project commenced in April 2017 with the aim to increase producer awareness of the potential issues and management strategies to deal with oestrogenic clover. The project was funded by Meat & Livestock Australia, with co-investment from Sheep Connect SA and Natural Resources South East. The project was managed and delivered by the MacKillop Farm Management Group in partnership with Agriculture Kangaroo Island. The project involved coaching producers from 10 focus farms across Kangaroo Island and the South East of SA in the identification of the clovers and the development of management plans and strategies for their properties. Paddocks on the focus farms were assessed using visual and laboratory analysis. Field days were held in the South East of South Australia and Kangaroo Island to train other producers in identification and management of oestrogenic clovers.

All key project objectives were achieved. In the final evaluation 89% of observer respondents indicated that the project had increased their knowledge and awareness of oestrogenic clovers and 74% of respondents adopted the key message of selecting grazing paddocks for stock based on class of stock and/or potency rating of paddocks (see 4.7.1)

The final evaluation of core producers indicated that 91% of respondents had already adopted the key message of selecting grazing paddocks for stock based on class of stock and/or potency rating of paddocks. 100% of respondents indicated that they would adopt the practice in time. 55% of respondents had adopted measures to reduce potency of paddocks by pasture renovation or manipulation. 100% of respondents indicated they will adopt the practice in time (see Section 4.7.3)

Varieties of oestrogenic clover include Dinninup, Dwalganup, Yarloop and Geraldton. Substances in these clovers, known as isoflavones, have an effect on sheep similar to that of natural oestrogens. These isoflavones are responsible for a variety of symptoms in sheep including lowered ewe fertility, increased difficult births, prolapse of the uterus, udder development in maiden ewes and wethers and urethral blockages in wethers. Isoflavones are potent to sheep when the plant material is green. As the plant senesces or 'dies off' the isoflavones break down and the plant material is safe. Hay and silage cut from paddocks containing high levels of oestrogenic clover can also be problematic, particularly if it has been cut and cured at the ideal time, and the plant material has kept its color.

Isoflavones can be measured in a laboratory test. The threshold level, at which fertility issues are likely to occur is 1,000mg/kg. A 2016 silage sample obtained from one of the producers involved in this project returned an isoflavone level of 6,280mg/kg.

There is no cure for the permanent infertility in ewes that have repeated exposure to large amounts of oestrogenic clovers over a long period of time. These ewes should be culled. The cumulative effect may occur over a 2-3 year period of exposure. Pastures with greater than 20% oestrogenic clovers are considered problematic.

Paddocks that have been identified as having greater than 20% oestrogenic clover should not be grazed with ewes whilst the clover is green, but can be grazed with terminal lambs. Drilling in winter feed (e.g. grasses or forage cereals) to dilute the clover and avoid grass and broadleaf weed cleaning highly oestrogenic pastures is also recommended.

Long term renovation of pastures with low oestrogenic cultivars will improve productivity. However, seed reserves in the soil often mean that renovation will not completely remove all the oestrogenic clovers from a pasture. Ensuring new varieties can dominate through adequate soil nutrition, weed and insect control is important. In the years prior to renovation reducing seed set of oestrogenic cultivars should be considered. In paddocks which can be cropped, encouraging germination via shallow tillage will help maximise germination and the effectiveness of herbicide applications to reduce seed banks. Cutting hay or silage can reduce seed set in a paddock the year before a paddock is renovated and will help reduce the seed bank and reduce competition for the establishment of new cultivars.

At the commencement of the project, 160 producers were surveyed to provide a benchmark on the awareness of oestrogenic clover on their properties. The majority of producers were unaware of the presence of oestrogenic clover, and most were not confident in identifying the oestrogenic clovers. The survey results showed that 85% of producers had never undertaken a visual assessment or laboratory analysis of their clover pastures.

The laboratory test for isoflavones is currently provided by only one commercial laboratory in Australia. Critical levels of the isoflavones, Diadzien and formononetin, is believed to be less than 1,000 mg/kg. There is however little detail on sampling technique and interpretation of results. This project has undertaken visual and laboratory analysis of paddocks. Initial laboratory results have been somewhat inconsistent with the visual paddock assessments undertaken, possibly due to sampling method and plant maturity. Initial recommendations from the laboratory indicated that leaf only or the whole plant were both suitable. The project has found differences between samples that include stems versus samples with leaf only. Concentrations of the isoflavones were higher in the leaf only samples. It was also found that plants that had started to senesce had lower isoflavone levels. Further monitoring and assessment of the laboratory analysis is required.

Visual assessments of 25 paddocks from 10 properties across the South East region of SA and on Kangaroo Island showed that 10 of these paddocks had the potential to cause fertility issues in ewes using the stick method which ranked them moderate to high. The visual assessments when combined with a laboratory test indicated that only 7 of the paddocks had the potential to cause flock issues.

This project has highlighted that whilst most producers have grasped the visual identification of problem clovers at field days, they don't have the confidence to conduct a detailed risk assessment of the paddock using the stick method back on their own property without technical advisor support. This training was outside the scope and the resources of this project and would require a coordinated training program. Most of the core producers were confident to be able to identify the bad cultivars on their farm, but still lacked the time and high skill levels to undertake a full farm risk assessment. A commercial agronomist on Kangaroo Island was trained to be 100% repeatable in identifying the four bad cultivars and was also competent in the stick method. More consideration is required in the development of 'best methods' to undertake risk assessments of paddocks and properties, which is important when developing and implementing management strategies. Greater

success for the industry may be to devise a simpler method of assessing paddocks, or training livestock advisors or agronomists to undertake paddock risk assessments.

Whole farm assessments were undertaken on the Focus Demonstration Farm (FDF) properties by the trained project staff using visual assessments to identify oestrogenic clover species and the stick method to provide an immediate, objective and repeatable method to determine the oestrogenic risk rating.

The Kangaroo Island FDF had paddock assessments undertaken on 13 paddocks. Of the 13 paddocks, 5 paddocks were low risk, 7 were moderate risk, and 1 was high risk (Table *1*). A property plan was developed as a result. Management will involve a combination of sheep and grazing management and pasture renovation as follows:

- Avoid grazing ewe weaners or younger ewes on the potent or moderate ranked pastures
- Continue grazing pastures with a low ranking in the same pattern
- Pregnancy scanning
- Increase ram percentage
- Continue to monitor clover composition of pastures (visually or by laboratory analysis)
- Be aware of pasture composition, particularly if the grass component is compromised
- Renovate the potent ranked pastures with 'good' clover cultivars and ryegrass mixtures

The South East FDF had a total of 21 paddocks assessed with 13 paddocks assessed as low risk, 6 as moderate risk, and 2 as high (Table *2*). A property plan was developed as a result of the whole farm assessment. Management will involve a combination of the following grazing management and pasture renovation strategies as indicated above:

- Continue grazing pastures with a low ranking in the same pattern
- Avoid grazing ewe weaners or younger ewes on the potent or moderate ranked pastures
- Continue to monitor clover composition of pastures (visually or by laboratory analysis)
- Be aware of pasture composition, particularly if the grass component is compromised
- Renovate the potent ranked pastures with 'good' clover cultivars and ryegrass mixtures
- Be aware silage and hay harvested from potent pastures may also be potent

Oestrogenic clover is far more prevalent in pastures in SA than first thought at the commencement of this project in 2017. Removing all oestrogenic cultivars from a system would be difficult but implementing agronomic, grazing and livestock management strategies can be effective in controlling the potential impacts they may have on a flock.

This project has demonstrated that if properly trained, producers can learn to identify all 4 oestrogenic cultivars, but they lack the confidence and time to undertake risk assessments of paddocks. Undertaking assessments of individual paddocks where oestrogenic clover has been identified is important to determine the risk that individual paddocks may pose and therefore formulate a whole farm management plan.

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1 Background

1.1 Clover disease

Some older sub clover cultivars that were widely sown in Australia from the 1930s to 1980s have high levels of oestrogenic compounds. While newer cultivars have been selected to avoid this problem, remnant populations of the older sub clovers can still potentially impact sheep production. Although the older oestrogenic ('bad') sub clovers have not been planted for many years, like all sub clovers they produce a percentage of hard seed that can survive false breaks and dry springs and therefore persist in many paddocks.

Sheep grazing pastures containing oestrogenic sub clover can be affected by a number of reproductive disorders which together form 'clover disease'. Clover disease affects ewes and wethers. Symptoms include lowered ewe fertility, increased difficult births, prolapse of the uterus, udder development in maiden ewes and wethers, and enlarged bulbourethral glands and urethral blockages in wethers. Clover disease will impact sheep when oestrogenic clovers make up 20 percent of the pasture eaten by sheep. Temporary infertility can occur where ewes graze germinating or green oestrogenic clover at mating or six weeks before mating. Permanent infertility occurs when ewes graze oestrogenic pastures for 2-3 years.

The main oestrogenic sub clover cultivars of concern are Dinninup, Dwalganup, Yarloop and Geraldton. Simply, these cultivars have substances in their leaves at a higher concentration than other cultivars that have an effect on sheep similar to that of natural oestrogens. The isoflavone formononetin is the most active of these substances and clover cultivars containing high levels of isoflavones s are known as oestrogenic clovers.

Levels of isoflavones are potent to sheep while the leaf material is still green, however as the leaf senesces the isoflavones are broken down and so grazing dry pasture has reduced risk. On the other hand, if very good clover hay or silage is made from the oestrogenic clovers and the leaf material is cured very well and has kept its colour, the hay or silage can still be oestrogenic.

Oestrogenic clovers are difficult to completely eradicate and management of them is the most practical way of minimising any potential flock issues they may pose. Management strategies are either agronomic or use strategic grazing. Grazing and fodder strategies include:

- Not grazing young ewes on oestrogenic paddocks
- Avoiding long term exposure of ewes to large amounts of oestrogenic clovers, as this can cause permanent infertility
- Reserving high risk paddocks for finishing terminal lambs
- Grazing ewes on low risk paddocks.
- Waiting until 6 weeks after the plant senesces or dies off and the plant material is safe for grazing ewes
- Not making hay and silage from oestrogenic clover paddocks
- Avoiding grazing ewes on oestrogenic clovers prior to or during mating as the clover can cause a temporary infertility
- Awareness that purchased hay/silage for feeding ewes could contain high oestrogenic clovers

Agronomic Strategies include:

- Diluting clover-based pastures with newer, non-oestrogenic clovers or other pasture species
- Ensuring new varieties can dominate through adequate soil nutrition, weed and insect control
- Developing a long-term strategic spraying and grazing program with input from an agronomist to prevent clover seed set and reduce the seed bank of oestrogenic clovers
- Encouraging germination of clover via shallow tillage to maximise effectiveness of herbicide applications
- Cutting hay and silage to reduce seed set, but be aware that this may still contain high levels of phytoestrogens
- Incorporate problem paddocks into a cropping rotation
- Buy certified clover seed to ensure it does not contain older varieties

2 Project objectives

2.1 Objectives

The overall project objective was to create awareness of the presence of oestrogenic clovers in the South East of South Australia and Kangaroo Island, the potential symptoms and impacts on sheep flocks and management options for oestrogenic clover. The project also had a focus on training producers in the identification of oestroegenic clovers, how to undertake risk assessments in paddocks and develop management strategies for their properties.

Measurable project objectives included:

- Increase the awareness of 70% of the collaborating group members on the issues encountered with oestrogenic clovers; and
- 90% of the of the core group producers adopting practices to reduce the impacts of clover disease, resulting in increased ewes scanned in lamb by 20%, increased marking percentage by 10% and decreased dry ewes by 5%.

3 Methodology

3.1 MacKillop Farm Management Group and Agriculture Kangaroo Island

This project was a collaborative project between Mackillop Farm Management Group (MFMG) and Agriculture Kangaroo Island (AGKI). MFMG has 295 members which includes 125 farm businesses and covers an estimated 500,000 ha and AGKI has 154 members including 124 farm businesses and covers approximately 200,000 ha.

3.2 Focus Demonstration Farms & Subsidiary Demonstration Farms

Two properties were identified to be Focus Demonstration Farms (FDF) for the upskilling of other producers. The FDFs were established at Richard Kirkland's property at Furner in the South East, and at Simon Veitch's property on Kangaroo Island.

Five other properties were identified as Subsidiary Demonstration Farms (SDF) associated with each FDF, and formed the core group of producers.

The project aimed to upskill the core FDF and SDF producers in oestrogenic clover identification through coaching and technical advice on practices to decrease or eliminate the impacts of oestrogenic clover. The key management strategies that producers needed to consider in identifying a potential issue and developing farm plans to address potential issues with oestrogenic clover included:

- Benchmarking reproductive efficiency through evaluation of pregnancy scanning data for conception, lamb marking data for lambing percentages and wet and drying ewes to determine dry ewe percentage. If there was a potential flock fertility issue then determining when it was occurring, what the potential causes were and if oestrogenic clover could be a contributing factor are important.
- Pasture assessments undertaken to quantify the level of oestrogenic clover and determine if the levels of oestrogenic clover were greater than 20%.
- If oestrogenic clover was present, develop grazing management plans to reduce the potential impacts i.e. grazing young ewes on non-oestrogenic pastures or on low risk pastures.
- Developing whole farm management plans which included strategies such as pasture renovation and cropping paddocks.

Reproductive performance and pastures assessments were undertaken on each of the properties with management plans developed for the FDFs and management recommendations given to the SDF properties. Whole farm assessments were undertaken by technical advisors on the FDFs.

3.3 Fact sheets

Two fact sheets were developed at the commencement of the project to be used as supporting information for FDF and SDF properties involved in the project. These fact sheets were also distributed at field days, available on the MFMG website and sent as a resource to producers and advisors contacting the project for further information as a result of media articles. See 7.1 for these fact sheets.

3.4 Visual paddock assessments

3.4.1 Clover identification

The identification of the four problematic clovers Dinninup, Dwalganup, Yarloop and Geraldton require three parts of the clover to be examined including the leaf markings, the hairiness of the runner and the colour of the calyx located below the petals of the flower. More than one leaf on a plant should be examined as markings can vary with growth stage and environmental conditions. A clover identification factsheet (7.1.2) and assessment sheet (7.1.3) were developed to support and train producers in the identification of the clovers.

3.4.2 Risk rating using the 'stick' method

The 'stick' method is an immediate, objective and repeatable pasture assessment tool modified to provide a pasture oestrogenicity score and a measure of the percentage of high oestrogen cultivars to low oestrogen cultivars within a pasture. The method was correlated against other pasture assessment methods including pasture cuts and hand sorting clover cultivars on a dry matter basis at Parndana KI in the 1980s.

Developing a risk rating for a paddocks using a stick method requires a stick about 0.5m long and walking diagonally across a paddock throwing the stick every ten paces for a minimum of 50 throws. Each end of the stick becomes a sample with one observation recorded at each end of the stick (total 2 observations), which gives 100 readings. Observations must record plant type i.e. clover, grass or other and record nearest clover variety, and then calculate the proportion of grass, clover and other species present. Of the clover portion a calculation of the percentage of oestrogenic clover is determined and a paddock risk ranking calculated expressed as a percentage. For further information on how to use the stick method to assess pastures see 7.2.

3.5 Laboratory analysis for potency of oestrogenic sub clovers

The laboratory test for isoflavones, the substances that mimic the natural oestrogens in sheep, is currently provided by only one commercial laboratory in Australia. Critical levels of the isoflavones diadzein and formononetin are believed to be less than 1,000 mg/kg. Later in the project due to collaboration with the University of Western Australia MLA Donor Company (MDC) project through Dr Kevin Foster, sample kits were provided for field day participants and demonstration properties. The technique varied from the commercial laboratory as whole leaves were sampled. Unfortunately at the time of reporting the results are not available from the UWA laboratory. Results will be available in early 2020 and will be forwarded to producers. This project undertook both visual and laboratory analysis of paddocks and compared and combined the results.

3.5.1 Sampling method

The preferred sampling method is to collect the leaf only of sub clovers present in the paddock. As a result of the project sampling it was found that the collection of whole plants, stem or other species of pasture or weeds distorts or provided a different result, indicating further calibration is required for this test. It is recommended that at least 40 samples over a cross section of the paddock are taken to ensure samples are representative of the paddock, and the samples must be taken before the plants have started to senesce. Once plants have started to senesce the phytoestrogens decline in the plant and the sample is no longer representative. Samples should be placed in paper bags to dry to avoid sweating in plastic bags. Samples were sent earlier in the week to avoid samples sitting in the post over the weekend.

3.5.2 Results

Results are expressed in mg/kg at 100% dry-matter and phytoestrogens are calculated using the isoflavones diadzein and formononetin. Work undertaken over the last few years suggests diadzein and formononetin levels need to be under 1000 mg/kg to prevent fertility problems. It is important to undertake a visual assessment of the pasture in conjunction with a laboratory test to determine

the percentage of clovers present in relation to other total plant species on a dry matter basis. A calculation is then made to determine the risk that paddock may pose to sheep fertility.

3.5.3 Laboratory details

Samples were posted to Southern Scientific Services based at Hamilton in Victoria. Samples were also posted to the University of Western Australia as part of an MDC funded project also focusing on the identification and remediation of oestrogenic sub clovers in pastures.

3.6 Awareness and upskilling

3.6.1 Coaching

Awareness and upskilling was achieved by coaching FDF and SDF producers on farm in the identification of oestrogenic clovers and how to undertake a paddock risk assessment. Due to the complexity and time involved in undertaking a whole farm assessment, the technical advisors undertook the whole farm assessment and then developed a management plan on behalf of the FDF producers.

3.6.2 Field days and extension activities

Field day and extension activities throughout the project include the following:

- South Australian Livestock Consultants Update, Primary Industries and Regions, Struan House, 9th November 2017, presentation.
- Rural Solutions SA Consultant Conference, 7th December 2017, presentation.
- Mackillop Farm Management Group Autumn Update 27th March 2018, presentation.
- MacKillop Farm Management Group Spring Livestock Field Day 11th September 2018, FDF (Richard Kirkland), Presentation and in paddock training session on identifying clovers and undertaking a paddock assessment.
- Agriculture Kangaroo Island Field Day, 8th and 9th October 2018, FDF (Simon Veitch, Keith Bolto and Ron Ham), presentation and in paddock training session on identifying clovers and undertaking a paddock assessment.
- Parndana Show Kangaroo Island, 10th November 2018
- MacKillop Farm Management Spring Livestock Field Day 2019, 12th September 2019, presentation
- Agriculture Kangaroo Island Field Day 1st and 2nd October 2019, SDF (Andrew Heinrich and Ashley Ness), presentation and in paddock training session on identifying clovers and undertaking a paddock assessment.
- Parndana Show Kangaroo Island, 16th November 2019
- Rural Solutions SA Consultant Conference, 12th December 2019

3.6.3 Communication

Communication and updates were delivered via e-newsletters to Sheep Connect SA, MacKillop Farm Management Group, Agriculture Kangaroo Island and the Barossa Improved Grazing Group throughout the project. Articles were printed in rural media platforms including From the Ground Up, an MLA approved article in AWI's Beyond the Bale, the Stock Journal Sheep Connect features, MLA Feedback Magazine and Kangaroo Island's local paper The Islander.

3.7 Evaluation

Pre and post evaluation was undertaken with all core producers at the commencement of the project and the conclusion of the project. Pre and post evaluation was also undertaken with core producers at the initial on-farm hands-on training day where they were coached to identify oestrogenic clovers and undertake a paddock risk assessment.

A pre and post survey was conducted with producers not directly involved in the project, referred to as 'observer' producers. This was done at the initial field days held on Kangaroo Island with the Agriculture Kangaroo Island group and the South East with the Mackillop Farm Management Group. Producers who are not members of these groups attended the field days also.

4 Results

4.1 Identification and risk assessment of paddocks

Whilst most producers have grasped the visual identification of problem clovers at field days or when supported by a technical advisor, they don't have the confidence to conduct a detailed risk assessment of the paddock using the stick method on their own property without technical advisor support. This is because the assessments of paddocks is something they find complex and time consuming.

This highlights the fact that more consideration is required in the development of 'best methods' to undertake risk assessments of paddocks and properties, which is important when developing and implementing management strategies. Greater success for the industry may be to devise a simpler method of assessing paddocks, or training livestock advisors or agronomists to undertake paddock risk assessments.

4.2 Laboratory analysis of oestrogenic clovers

The project found differences between samples that include stems versus samples with leaf only. Concentrations of the isoflavones were higher in the leaf only samples. Initial recommendations from the laboratory indicated that leaf only or the whole plant were both suitable. It was also found that plants that had started to senesce had lower isoflavone levels. Laboratory results have been somewhat inconsistent with the visual paddock assessments undertaken in this project. This is thought to be due to sampling method and plant maturity.

4.3 Whole farm assessments- Focus Demonstration Farms

Whole farm assessments have been undertaken on the FDF properties using visual assessments to identify oestrogenic clover species and the stick method to determine the risk rating.

The Kangaroo Island FDF had paddock assessments undertaken on 13 paddocks. Of the 13 paddocks, 5 paddocks were low risk, 7 were moderate risk, and 1 high risk (Table *1*). A property plan was developed as a result. Management will involve a combination of sheep and grazing management and pasture renovation as follows:

- Pregnancy scanning
- Increase ram percentage
- Continue grazing pastures with a low ranking in the same pattern
- Avoid grazing ewe weaners or younger ewes on the potent or moderate ranked pastures
- Continue to monitor clover composition of pastures (visually or by laboratory analysis)
- Be aware of pasture composition, particularly if the grass component is compromised
- Renovate the potent ranked pastures with 'good' clover cultivars and ryegrass mixtures

Table 1 Paddock assessment results Kangaroo Island Focus Demonstration Farm (2018)

Paddock	Grass%	Broadleaf %	Clover%	Oestrogenic clover %	Clover cultivar %	Pasture oestrogen score
1 – 18 (20ha)	Cut for hay 2018				Dinninup present	
2 – 18 (27ha)	59	12	29	58	Dinninup 55 Dwalganup 3 Trikkala 15 Cluster 19 Daliak 3 Strawberry 3	17 - Low
3 – 18 (21ha)	50	17	33	62	Dinninup 48 Dwalganup 10 Yarloop 4 Trikkala 18 Cluster 8 Seaton Park 3 Balansa 1 Strawberry 1 Bare 7	12 - Low
4 – 18 (44ha)	51	33	8	16	Dinninup - 12 Dwalganup - 4 Medic - 4 Cluster - 3 Hop - 2 Bare 75	1 – Low

5 – 18 (33ha)	47	9	45	56	Dinninup 51 Dwalganup 3 Yarloop 1 Geraldton 1 Cluster 27 Seaton Park 15 Daliak 1 Trikkala 1	25 - Moderate
6 – 18 (5.5ha)	59	10	31	82	Dinninup 77 Dwalganup 4 Geraldton 1 Cluster 6 Woogenellup 4 Trikkala 3 Strawberry 2 Unknown 3	25 - Moderate
7 – 18 (10ha)	29	18	53	93	Dinninup 92 Yarloop 1 Trikkala 3 Strawberry 2 Seaton Park 1 Cluster 1	49 - Potent
8 – 18 (22.4ha)	65	6	29	16	Dinninup 15 Yarloop 1 Cluster 74 Trikkala 8 Balansa 2	5 - Low
9 – 18 (23ha)	46	4	50	63	Dinninup 50 Dwalganup 10 Yarloop 3 Cluster 33 Trikkala 4	32 - Moderate
10 – 18 (14ha)	57	6	37	90	Dinninup 87 Dwalganup 3 Cluster 8 Daliak 1 Balansa 1	33 - Moderate
11 – 18 (14ha)	35	13	52	67	Dinninup 67 Trikkala 21 Cluster 4 Balansa 2 Mt Barker 2 Daliak 1	35 - Moderate

					Bare 3	
12 – 18 (12ha)	31	28	41	92	Dinninup 91 Dwalganup 1 Trikkala 5 Cluster 2 Daliak 1	38 – Moderate
13 – 18 (39ha)	64	13	23	94	Dinninup 69 Dwalganup 25 Cluster 3 Seaton Park 1 Trikkala 1 Daliak 1	22 – Moderate
14 – 18 (44ha)	69	10	21	39	Dinninup 7 Dwalganup 27 Yarloop 5 Cluster 25 Medic 4 Trikkala 3 Daliak 1 Bacchus Marsh 1 Bare 27	8 – Low

The South East FDF had a total of 21 paddocks assessed with 13 paddocks assessed as low risk, 6 moderate risk, and 2 high risk (Table *2*). A property plan was developed as a result of the whole farm assessment. Management will involve a combination of the following grazing management and pasture renovation strategies as indicated above:

- Continue grazing pastures with a low ranking in the same pattern
- Avoid grazing ewe weaners or younger ewes on the potent or moderate ranked pastures
- Continue to monitor clover composition of pastures (visually or by laboratory analysis)
- Be aware of pasture composition, particularly if the grass component is compromised
- Renovate the potent ranked pastures with 'good' clover cultivars and ryegrass mixtures
- Be aware silage and hay harvested from potent pastures may also be potent

Table 2 Paddock assessment results South East Focus Demonstration Farm (2018)

Paddock	Grass%	Broadleaf %	Clover%	Oestrogenic Clover %	Clover Cultivar %	Pasture Oestrogen Score
1 – 17* (31ha)	12	7	81	**35**	Dinninup 16 Yarloop 19 Trikkala 54 Woogenellup 7 Cluster 4	**28 - Moderate**

2– 17* (56ha)	6	0	94	**28**	Yarloop 28 Trikkala 72	**26 - Moderate**
3 – 18 (34ha)	**Cut for silage 2018**				Dinninup present	
4 – 18 (49ha)	15	0	85	**20**	Yarloop 20 Trikkala 78 Balansa 2	**17 - Low**
5 – 18 (36ha) Incl (12ha)	18	2	80	**62**	Yarloop 57 Dinninup 5 Trikkala 37 Antas 1	**50 - Potent**
6 – 18 (68ha)	24	2	74	**29**	Yarloop 26 Dinninup 3 Trikkala 71	**22 - Moderate**
7 – 18 (45ha)	18	17	65	**24**	Yarloop 21 Dinninup 1.5 Dwalganup 1.5 Trikkala 76 Woogenellup 3	**16 - Low**
8 - 18 (47ha)	13	7	80	**21**	Yarloop 19 Dinninup 2 Trikkala 79	**17 - Low**
9 – 18 (28ha)	3	0	97	**14**	Yarloop 14 Trikkala 55 Gosse 30 Persian 1	**14 - Low**
10 – 18 (42ha ?)	13	0	87	**2**	Yarloop 2 Trikkala 97 Balansa 1	**2 - Low**
11 – 18 (30ha)	2	0	98	**3**	Yarloop 3 Trikkala 95 Gosse 2	**3 - Low**
12 – 18 (26ha)	3	0	97	**2**	Yarloop 2 Trikkala 96 Gosse 1 Balansa 1	**2 - Low**
13 – 18 (25ha)	11	1	88	**5**	Yarloop 5 Trikkala 94 Shaftal 1	**4 - Low**

14– 18 (34ha)	34	0	66	**1**	Yarloop 1 Trikkala 99	**1 – Low**
15 – 18 (48ha)	31	0	69	**9**	Yarloop 8 Dinninup 1 Balansa 54 Trikkala 22 Medic 9 Shaftal 6	**6 – Low**
16 – 18 (45ha)	3	0	97	**5**	Yarloop 5 Trikkala 45 Balansa 21 Clare 21 Medic 3 Woogenellup 2 Antas 2 Gosse 1	**5 – Low**
17 – 18 (31ha)	17	9	74	**20**	Yarloop 10 Dinninup 10 Trikkala 73 Woogenellup 3 Clare 2 Gosse 1 Balansa 1	**15 - Low**
18 – 18	3	17	80	**41**	Yarloop 32 Dinninup 9 Trikkala 54 Woogenellup 5	**33 - Moderate**
19 - 18	13	10	77	**32**	Yarloop 25 Dinninup 7 Riverina 42 Balansa 9 Mt Barker 8 Trikkala 2 Shaftal 2 Woogenellup 2 Antas 1 Medic 1 Seaton Park 1	**25 - Moderate**
20 – 18	19	3	78	**30**	Yarloop 27 Dinninup 3 Balansa 43 Riverina 23 Trikkala 2	**23 - Moderate**

					Woogenellup 1 Shaftal 1	
21 – 18	39	10	51	**18**	Yarloop 14 Dinninup 3 Dwalganup 1 Shaftal 47 Balansa 19 Trikkala 12 Medic 4	**9 - Low**
22 – 18	20	2	78	**74**	Yarloop 71 Dinninup 3 Shaftal 19 Balansa 5 Trikkala 2	**58 - Potent**

4.4 Paddock assessments for Subsidiary Demonstration Farms

Early in the project visual assessments and laboratory tests were undertaken from 25 paddocks across the 10 SDF and FDF properties in the South East of SA and Kangaroo Island. More paddocks were assessed on FDF and SDF properties in 2018 and 2019. Of the initial 25 paddocks, 20 paddocks had greater than 20% oestrogenic clovers present in the clover proportion of the paddock. Of those paddocks, 50% have the potential to cause fertility issues in ewes, with visual assessments ranking them moderate to high.

Laboratory and visual assessment results are summarised in Table 3 and Table 4. Laboratory Phytoestrogens includes the combined levels of the isoflavones of diadzein and formononetin expressed as mg/kg at 100% dry matter. Threshold level of diadzein and formononetin is at 1,000mg/kg (dry weight). Greater than this level ewe fertility is likely to be affected.

A total of 9 paddocks were assessed on south east properties**.** Of the paddocks assessed seven paddocks had greater than 20% oestrogenic clover in the clover portion of the pasture with three of these paddocks having a moderate risk score and one paddock with a risk scored rated as high in pasture oestrogens. Paddocks with a moderate to high levels of pasture oestrogens are likely to be detrimental for lambing ewe flocks.

On Kangaroo Island 16 paddocks were assessed for the presence of oestrogenic clover. Oestrogenic clover in the clover portion of the pasture ranged from 6% to 92% with eleven of the sixteen paddocks having greater than 20% oestrogenic clover. Two paddocks had greater than 20% oestrogen clovers, two paddocks had greater than 30% oestrogenic clovers, three paddocks had greater than 50% oestrogenic clovers and 4 paddocks had greater than 80% oestrogenic clovers.

Isoflavone levels vary with the maturity of the plants. This was demonstrated when comparing the results from MacGillivray 7 at 2,580mg/kg where plants were senescing and were affected by a Red Legged Earth Mite infestation, compared to healthy and actively growing MacGillivray 8 at

5,190mg/kg. Both these paddocks had high scores of oestrogenic clover as part of the clover %, although pasture scores varied due to botanical composition differences.

Table 3 South East results

	Visual paddock assessments					Laboratory analysis	Laboratory and visual assessment combined
Location	Grass %	Weed %	Clover %	% of Oestrogenic clover in the total amount of clover	Pasture oestrogen Score*	Isoflavones dia and form (mg/kg)	Estimated isoflavones as consumed by animal in total pasture consumption
Binnum 1	8	17	75	75	56 (H)	333	249
Binnum 2	55	5	40	55	22 (M)	815	326
Frances 1	17	0	83	5	4 (L)	3750	3113**
Frances 2	63	4	33	71	23 (M)	384	127
VIC 1	21	0	79	17	13 (L)	584	461
VIC 2	57	0	43	46	20 (L)	975	419
Lucindale 1	54	0	46	42	19 (L)ow	3320	1481**
Furner 1	12	7	81	35	28 (M)	5570	4500**
Furner 2	6	0	94	28	26 (M)	686	644

* Pasture oestrogen score – visual assessment 1-20% low; 21-40% moderate; > 40% high

** Toxic levels of isoflavones (as consumed by animal in total pasture consumed)

Table 4 Kangaroo Island results

	Visual paddock assessments					Laboratory analysis	Laboratory and visual assessment combined
Location	Grass %	Weed %	Clover %	% of Oestrogenic clover in the total amount of clover	Pasture oestrogen Score*	Isoflavones dia and form (mg/kg)	Estimated isoflavones as consumed by animal in total pasture consumption
MacGillivray 1	44	0	56	92	52 (H)	1810	1014**
MacGillivary 2	69	6	25	25	6 (L)	na	na
MacGillivary 3	na	na	na	na	na	750	150
Ritchie 1	10	49	41	53	22 (M)	2640	1082**
Ritchie 2	46	10	42	28	12 (L)	1170	491
Ritchie 3	34	16	38	16	6 (L)	nt	na
Ritchie 4	58	20	22	32	7 (L)	nt	na
Ritchie 5	39	22	29	30	12 (L)	nt	na
Ritchie 6	68	10	22	6	1 (L)	nt	na
MacGillivary 4	34	40	26	68	18 (L)	2840	738
MacGillivary 5	46	18	36	18	7 (L)	628	226
MacGillivary 6	18	18	64	18	12 (L)	1220	780

MacGillivary 7	58	32	10	90	9 (L)	2580	258
MacGillivary 8	10	50	42	88	37 (M)	5190	2179**
MacGillivary 9	10	44	46	78	36 (M)	5710	2627**
MacGillivary 10	14	52	34	60	21 (M)	1130	384

na – not assessed; nt – not tested

* Pasture oestrogen score – visual assessment 1-20% low; 21-40% moderate; > 40% high

** Toxic levels of isoflavones (as consumed by animal in total pasture consumed)

4.5 Focus Demonstration Farm whole farm management plans

Whole farm management plans were developed for the FDF properties. The original methodology was for the FDF producers to be trained in the identification and risk assessment of paddocks and then undertake a whole farm assessment and with the support of technical advisors of the project develop a management plan for their properties. Due to the complexity and time involved in undertaking a whole farm assessment the technical advisors undertook the whole farm assessment and then developed a management plan on behalf of the FDF producers. FDF producers became competent in the identification of problem clover species with these producers being called on by other producers in their region to help them identify problem clovers.

4.5.1 Simon Veitch, MacGillivray

Property owner: Simon Veitch

Property name: '*Karinga*'

Location: MacGillivray, Kangaroo Island

Annual rainfall: 550 mm

Property size: 635 hectares and leased block

Enterprises: 1,600 Merino ewes and 190 breeder cattle

Cropping (cereals, legumes and canola)

Pasture type: Mix of annual (sub clover, balansa clover, naturalised clovers, medics, ryegrass, silver grass, brome grass, barley grass, capeweed, storksbill) and perennials (puccinellia, phalaris & minor patches of strawberry clover)

Soil type: Sandy loam over clay, lateritic sandy loam over clay and saline soil

Paddock survey- oestrogenic clover scores

The management plan is based firstly on the identification of paddocks with a higher percentage of oestrogenic clovers. These paddocks are then ranked in priority.

Thirteen paddocks of the home block used for grazing have a Pasture Oestrogenic Score (POS) (*Table 1*). The leased block used for cropping and grazing ewe and wether weaners was not scored. The leased block has oestrogenic clover cultivars but the level is yet to be determined. A southern block

is predominately used for cropping and cattle grazing, and the level of oestrogenic clover cultivars is unknown. The block does not have the infrastructure for managing ewe flocks and is retained for cattle grazing.

Of the 13 paddocks surveyed, 5 paddocks had low POS, 7 paddocks a moderate POS and 1 paddock with a potent POS. Paddock 7 is potent due to the high clover composition in the pasture and a high oestrogenic clover content of Dinninup and Yarloop sub clover.

Paddocks 5, 6, 9, 11, 12, and 13 were all moderate POS, characterised by good clover composition combined with a moderate to high level of oestrogenic clover cultivars.

Its recommended that a clover survey be conducted on the leased and southern blocks to determine if more low oestrogen pastures are available for the breeding flocks and explore cropping options on the home block to aid in the future renovation of bad pastures.

Management options

Continue to monitor the clover composition of the pastures as a variation in seasonal break, change in stocking rates and red legged earth mite damage can severely alter the clover establishment and productivity.

Potent POS paddocks – 7

- Long term – paddock 7 should be renovated with low oestrogen cultivars of sub clovers and other pasture species after a program to reduce seed numbers of the bad clovers.
- Short term – these paddocks should be grazed with sale stock or an older age group of ewes only. Sowing cereals and improved ryegrasses into the mix to lower the clover content may be less productive over time as clover content needs to be below 20%.

Moderate POS paddocks – 5, 6, 9, 10, 11, 12 and 13

- Long term – renovate paddocks 9, 10, 11, 12 and 13 due to the relatively high oestrogenic clover content and replace with low oestrogen cultivars. Grazing paddocks 9, 10, 11 and 12 with older age groups of ewes and sale stock. Paddock 13 currently has a high grass content and needs to be monitored each season. Paddock 6 can be retained for grazing by rams.
- Short term – maintain grass content at the expense of clover content by reducing stocking rate to promote grass content in pastures and/or sowing cereals and improved ryegrasses in all moderate paddocks to dilute the clover content and reduce overall oestrogen intake. Graze with older age groups of ewes. Monitor the grass and clover content of paddock 5 and adjust by sowing cereals or improved ryegrasses to reduce clover content of the pasture. Graze with mid aged or older ewe mobs.

Low POS Paddocks – 2, 3, 4, 8, and 14

- Select the lowest scoring paddocks 4 and 8 for ewe weaner flocks and allocate the remaining paddocks to be grazed by the younger and mid aged groups of ewes.
- Carefully monitor paddocks 2 and 3 each season for clover content relative to grass content due to the high proportion of oestrogenic clovers in the population.
- Maintain current management to retain low oestrogen clover content in paddock 8.

- Consider trialling salt tolerant broadleaf Messina in paddocks 4 and 14 to improve productivity.

Haymaking and silage

- Grow specialty hay crops for harvesting for hay or silage in the cropped paddocks as an alternative to cutting clovers in the low POS paddocks reducing the risk of diminishing future clover content.
- Be aware that silage and hay harvested from potent pastures may also be potent.

4.5.2 Richard Kirkland, Furner

Property owner:	Richard Kirkland
Property name:	'*Kirkland*'
Location:	Furner, SE
Annual rainfall:	600 mm
Property size:	2,000 hectares
Enterprises:	8,400 Merino/Border Leicester, Composite and White Suffolk and Poll Dorset crossbreds 700 ha crop (beans, wheat & canola)
Pasture type:	Mix of annual (sub clover, balansa clover, arrowleaf clover, naturalised clovers, medics, persian clover, ryegrass, silver grass, brome grass, barley grass, capeweed, chickweed) and perennials (phalaris & ryegrass)
Soil type:	Red loam, black clay, sandy loam over clay

Paddock survey – oestrogenic clover scores

The management plan is based firstly on the identification of paddocks with a higher percentage of oestrogenic clovers. These paddocks are then ranked in priority.

All paddocks used for grazing have a Pasture Oestrogenic Score (POS) (Table *2*) and are predominately grazed by the weaners and ewe flocks. Cropping, ram and holding paddocks were not scored. Of the 21 paddocks surveyed, 13 paddocks had low POS, 6 paddocks a moderate POS and 2 paddocks with a potent POS. Paddocks 5 and 22 are potent due to the high clover composition in the pasture and a high oestrogenic clover content of Yarloop and Dinninup sub clover.

Paddock 5 had been previously renovated but was not as successful as that in adjacent paddocks. Paddock 22 is in a recently purchased block of land and the oestrogenic clover content was not known at purchase. The paddocks of moderate POS, paddocks 1, 2, 6, 18, 19, and 20 are characterised by good clover composition combined with a moderate level of oestrogenic clover cultivars. Paddocks 18, 19 and 20 were also in the recently purchased block and the level of oestrogenic clover content was also unknown.

Management options

Continue to monitor the clover composition of the pastures as a variation in seasonal break, change in stocking rates and red legged earth mite damage can severely alter the clover establishment and productivity.

Potent POS paddocks – 5 and 22

- Long term - these paddocks should be renovated with low oestrogen cultivars of sub clovers and other pasture species after a program to reduce seed numbers of the bad clovers.
- Short term – these paddocks should be grazed with sale stock or an older age group of ewes only. Sowing cereals and improved ryegrasses into the mix to lower the clover content may be less productive over time as clover content needs to be below 30%.

Moderate POS paddocks – 1, 2, 6, 18, 19 and 20

- Long term – renovate paddocks 18 and 1 due to the relatively high oestrogenic clover content and replace with low oestrogen cultivars. Graze paddocks 18 and 1 with older age groups of ewes and sale stock.
- Short term – reduce stocking rate to promote grass content in pastures and/or sow cereals and improved ryegrasses in paddocks 2 and 19 to dilute the clover content, reducing overall oestrogen intake. Graze with older age groups of ewes. Monitor paddocks 6 and 20 for grass and clover content of pastures and adjust by sowing cereals or improved ryegrasses to reduce clover content of the pasture. Graze with mid aged ewe mobs.

Low POS Paddocks – 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 21

- Select the lowest scoring paddocks for ewe weaner flocks and allocate the remaining paddocks to be grazed by the younger and mid aged groups of ewes.
- Maintain current management to retain low oestrogen clover content in the pastures.

Haymaking and silage

- Grow specialty hay crops for harvesting for hay or silage in preference to cutting clovers in the low POS paddocks reducing the risk of diminishing future clover content.
- Be aware that silage and hay harvested from potent pastures may also be potent

4.6 Subsidiary Demonstration Farm management recommendations

The original methodology of the project was to train all the SDF producers in conjunction with the FDF producers and support the SDF producers to undertake whole farm assessments of their own properties and develop a whole farm management plan. The technical advisors for the project undertook assessments of some paddocks on the SDF properties and provided some direction and management options based on the sample of paddocks assessed. Similar to the FDF producers, the SDF producers whilst confident in identifying pastures and undertaking a risk assessment of a paddock with a technical advisor present found that undertaking identification of clovers and undertaking a risk assessment of a paddock on their own difficult and time and consuming.

4.6.1 Windee, Ritchie

Property owner:	V N and Y M Cox
	P Cox
Property name:	Windee
Location:	Ritchie, Kangaroo Island
Annual rainfall:	600 mm
Property size:	1,000 hectares
Enterprises:	2,500 crossbred (Border Leicester x Merino) and Highlander cross ewes
	100 breeder cattle
Pasture type:	Mix of annual (sub clover, balansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay, lateritic sandy loam over clay

Post field day and property inspection actions

- The landholders conducted a survey for bad clovers in remaining paddocks to test their skills and also determine the severity and extent of the bad clovers in their pastures. Areas of the bad clovers were confirmed but it was considered that the levels were not high.
- Normal practice had been to buy in replacement ewes but with the identification of a few safer low oestrogen paddocks ewe lambs were retained as future breeders on those paddocks. Lambing performance will be compared to other mobs.
- Higher fertile Highlander genetics has been trialled in 2018 to improve fertility and ease of lambing to increase weaning percentages. Ease of lambing produced more lambs/100 ewes in 2018 with a lamb marking percentage of 150%.

Future training

Landholders are interested in further training on identification and management of oestrogenic clovers, assistance in developing a management plan for their pastures and appropriate renovation techniques to establish low oestrogen sub clover cultivars.

4.6.2 Jakidyl, MacGillivray

Property owner:	Lockett Family
	B Lockett
Property name:	Jakidyl
Location:	MacGillivray, Kangaroo Island
Annual rainfall:	550 mm
Property size:	1,500 hectares
Enterprises:	5,500 Merino ewes
	100 breeder cattle
Pasture type:	Mix of annual (sub clover, balansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay

Post field day and property inspection actions

- The landholder inspected remaining paddocks for bad clover extent and severity. The landholder is confident in identifying Dinninup and Yarloop but requires further training in bad clover identification and development of an appropriate management plan.
- Renovation of an identified high oestrogen pasture with low oestrogen sub clover mix with good results.
- Implemented a red legged earth mite control program to produce more biomass with improved water use efficiency and extended growth of the lower oestrogen pastures.
- Investigating the abattoir surveillance of old age group ewes for uterine lesions through the local vet to confirm oestrogen damage.
- Implemented pregnancy scanning of ewes to identify dry ewes. Current lambing percentage ranges 78% to 86%.

Future training

Landholders are interested in further training on identification and management of oestrogenic clovers, assistance in developing a management plan for their pastures and appropriate renovation techniques to establish low oestrogen sub clover cultivars.

4.6.3 Fry Family Farms, Frances

Property owner:	Fry Family Farms
	T and C Fry
Property name:	East Ridings
Location:	Frances, South East of SA
Annual rainfall:	550 mm
Property size:	1,400 hectares
Enterprises:	1,300 Merino and 3,500 Border Leicester x Merino ewes
	70 breeder cattle
Pasture type:	Mix of annual (sub clover, balansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay

Post field day and property inspection actions:

- The landholders inspected the older pastures on the home block for bad clover extent and severity. The landholders were not confident in identifying the bad cultivars but suspected the cultivars were present. The landholders had renovated most of the pastures on the new block with low oestrogen cultivars and were confident bad clover levels would be lower. The landholders are interested in further training in identification of the bad cultivars to improve their confidence in decision making.
- More attention to scanning results with 9% dry ewes in Merino and Crossbred flocks, lambing percentages had improved with Merinos at 125% and crossbreds at 140%. Landholders were concerned with the number of difficult births and ewe deaths in 2018, possibly due to larger lambs with the seasonal conditions or other factors.
- Intend to renovate more of the older pastures with new low oestrogen cultivars of sub clovers and other pasture species. Historically seed had been harvested from paddock 2 which has a high level of high oestrogen cultivars and was resown on the home block and also sold to local farmers.

Future training

The landholders are interested in further training on identification and management of oestrogenic clovers. The landholders believe that the bad clovers are more widespread in the local area and that more skills, knowledge and discussion locally will improve productivity. As seed growers, they can provide information to assist farmers in the establishment of low oestrogen cultivars.

4.6.4 Karatta Pastoral, Binnum

Property owner:	Karatta Pastoral
	Manager J Partridge
Property name:	Karatta
Location:	Binnum, South East of SA
Annual rainfall:	550 mm
Property size:	2,000 hectares
Enterprises:	5,000 Merino and Merino/Border Leicester crossbred ewes
	200 breeder cattle
	Cropping cereals, oilseed and legumes
Pasture type:	Mix of annual (sub clover, balansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay

Post field day and property inspection actions

- The manager inspected remaining older pastures for the extent and severity of bad clovers. Areas of dominant high oestrogen cultivars were found but it was considered the dilution by the pasture mix would reduce the impact.
- Paddock 1 had a high content of high oestrogen cultivars. Previous years lambing data showed that lambing % was lower than similar mobs. Surrounding paddocks were checked for high oestrogen cultivars. The paddock in 2018 was grazed by sale stock only. Plan to renovate with low oestrogen cultivars of sub clover or retain for sale stock grazing.
- Lambing percentages have been satisfactory, with Merinos at 120% and crossbreds at 135% in 2018. The Merino ewes are bought in from low oestrogen districts (medic areas) and the first cross ewes are bred on farm. In 2019 for the first time the Merino ewe flock has been bred on farm on renovated pastures on the new block. Lambing performance will be monitored and compared with similar age groups.
- Implementation of a pasture renovation program with low oestrogen cultivars following a number of crop years is a strategy to be adopted.
- Suspected paddocks with high oestrogens in the short term will be sown with cereal or improved ryegrass mixes to dilute the intake of bad clovers and improve early biomass.

Future training

The manager is interested in further training on identification and management of oestrogenic clovers. He is confident with new cropping technology that he can renovate the older pastures with low oestrogen sub clover cultivars.

4.6.5 Orana, Lucindale

Property owner:	R and S Tregoweth
	P Tregoweth
Property name:	Orana
Location:	Lucindale, South East of SA
Annual rainfall:	550 mm
Property size:	1,200 hectares
Enterprises:	3,000 Merino ewes
	100 breeder cattle
Pasture type:	Mix of annual (sub clover, blansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay

Post field day and property inspection actions

- The landholder inspected the older pastures suspected to have the higher oestrogen cultivars, in particular Yarloop which was historically widely sown. The landholder was confident in identifying the Yarloop cultivar and found low numbers in suspected paddocks.
- The landholder will continue to monitor lambing performance. Currently the Merino lambing percentage is 110% and first cross Border Leicester Merino ewes (bred on the property) lambing percentage is 130%. The Merino ewes are bought in from a medic growing area at and would have a low oestrogen history.

Future training

The landholder is interested in further training on identification and management of oestrogenic clovers, as well as assistance in developing renovation techniques to establish low oestrogen sub clover cultivars.

4.6.6 Brippick, Wombelano

Property owner:	P Hawkins and T Hindson
Property name:	Brippick and Wombelano
Location:	Minimay and Wombelano, Victoria
Annual rainfall:	550 mm
Property size:	4,050 hectares
Enterprises:	11,000 ewes and 10,000 lambs (Merino and Dohne)
	200 Breeder cattle
	Cropping (Brippick)
Pasture type:	Mix of annual (sub clover, balansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay

Post field day and property inspection actions

- The landholder inspected remaining paddocks for bad clover extent and severity. They identified areas of concern but were not confident in the identification of all the bad clovers. Landholders are interested in further training and the development of management plan for problem paddocks.
- Average lambing percentages for the last three years has been Merino 80% and Dohne 100%, in 2018 some mobs were 105%. Looking to achieve consistent improvement in lambing percentages.
- Planning to renovate pastures with more low oestrogen sub clovers and other pasture species to improve clover composition and pasture productivity.
- Plan to analyse the pregnancy scanning results and lambing performance between the properties and compare expected lower oestrogen pastures on cropped paddocks at Brippick with other pastures.

Future training

The landholders are interested in further training on identification and management of oestrogenic clovers, as well as assistance in developing renovation techniques to establish low oestrogen sub clover cultivars.

4.6.7 Redlands, MacGillivray

Property owner:	Bolto Partners K Bolto
Property name:	Redlands
Location:	MacGillivray, Kangaroo Island
Annual rainfall:	550 mm
Property size:	1,750 hectares
Enterprises:	5,500 Merino ewes
Pasture type:	Mix of annual (sub clover, balansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay, lateritic sandy loam over clay

Post field day and property inspection actions

- The landholders inspected remaining older pastures and found a large number of paddocks with a high percentage of high oestrogen cultivars present. Pasture composition with a high percentage of grasses had diluted the impact of the bad clovers. Detailed survey of 30% of land area completed.
- Plan to develop management plan to renovate the paddocks with high percentages of bad clovers following a cropping program. Current lambing percentages range from 72- 88%.
- Graze younger ewes and the special ewe flock on the pastures with the lowest oestrogen content.
- In selected paddocks use cereals and ryegrasses sown into pastures to dilute bad clover impact and increase early biomass

Future training

The landholders are interested in further training on identification and management of oestrogenic clovers, as well as assistance in developing renovation techniques to establish low oestrogen sub clover cultivars following a cropping program.

4.6.8 Lake Knolls, MacGillivray

Property owner:	D Rowsell
Property name:	Lake Knolls
Location:	MacGillivray, Kangaroo Island
Annual rainfall:	550 mm
Property size:	350 hectares
Enterprises:	790 Merino ewes
Pasture type:	Mix of annual (sub clover, balansa clover, medics, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & kikuyu)
Soil type:	Sandy loam over clay

Post field day and property inspection actions

- The landholder inspected some of the remaining paddocks for the bad clovers to determine the severity and extent of the population in the pastures. The landholder was not confident in identifying the bad cultivars but suspected the cultivars were present and would require further training and assistance to determine actual levels.
- Lambing percentages in recent years have ranged from 87% to 92%. The retaining of a wether flock to replace a portion of the ewe flock is being considered a short-term strategy on higher oestrogen pastures.
- Renovation of pastures with high oestrogen content is being considered after a crop phase to reduce bad clover plant numbers.

Future training

The landholders are interested in further training on identification and management of oestrogenic clovers, as well as assistance in developing renovation techniques to establish low oestrogen sub clover cultivars. Advice will also be sought on the recommended cultivars and pasture mixes for the range of soils on the property.

4.6.9 Aroona, Seddon

Property owner:	KI Freight M Smith
Property name:	Aroona
Location:	Seddon, Kangaroo Island
Annual rainfall:	600 mm
Property size:	2,000 hectares
Enterprises:	5,000 Merino ewes
Pasture type:	Mix of annual (sub clover, balansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay

Post field day and property inspection actions

- The landholder used a private agronomist to inspect remaining older pastures for high oestrogen cultivars. The landholder has used a cropping program prior to renovate pastures in the past and paddock inspections confirmed the success rate. Paddock 3 had the highest level of high oestrogen cultivars.
- Continue monitoring lambing performance, currently satisfied with lambing percentages at 120%.

Future training

The landholder employs an agronomist to advise on cropping and pasture renovation programs. The agronomist is trained in the identification of high oestrogen sub clover cultivars and so the landholder will rely on his advice.

4.7 Evaluation

4.7.1 Pre and post survey observer producers

A total of 160 responses to the initial survey at the commencement of the project were received and 71 respondents were received for the final evaluation via Survey Monkey and field days.

1. **Are you a member of a producer group?**

71% of respondents were a member of a producer group

2. **If yes, which groups?**

Note multiple answers possible

	Initial *% of respondents*	*Final* *% of respondents*
Mackillop Farm Management Group	14	19
Agriculture KI	24	40
Other	40	23
Livestock SA	16	19
None	3	-

3. **Property location**

	Initial *% of respondents*	*Final* *% of respondents*
South East	66	29
Kangaroo Island	28	41
Eyre Peninsula	3	0
Mid North	3	-
Other – Barossa, Fleurieu and Adelaide Hills	4	29
No response	1	-

4. **Total area managed (hectares)**

All regions	*Initial* *% of respondents*	*Final* *% of respondents*
Min	81	10
Max	7284	10,000
Average	1211	1144

5. Ewe numbers Merino

All regions	*Initial % of respondents*	*Final % of respondents*
Min	50	50
Max	14,000	13,000
Average	2430	2643

6. Oestrogenic clovers are the key cause of clover disease in sheep. What symptoms do you believe are generally associated with clover disease?

	Initial % of respondents	*Final % of respondents*
Oestrogenic clover <20% of paddock composition	40	-
Lambing percentage >100%	22.5	55.6
>10% ewes lamb in the third and fourth cycles	22.5	30.6
< 10% dry ewes	17.5	0.0
>10% dry ewes	52.5	69.4
Wethers bagging up	62.5	52.8
Abortion	37.5	38.9
Weak lambs	12.5	13.9
Slow and difficult births (>1 in 100)	17.5	50.0
Ewe deaths >10%	12.5	11.1

7. Are you aware of oestrogenic clovers being present in your pastures?

	Initial % of respondents	*Final % of respondents*
Yes	32	60
No	38	22
Unsure	30	18

8. If yes, how confident are you in identifying the different oestrogenic clovers (i.e. Dwalganup, Dinninup, Yarloop, Geraldton)?

	Initial % of respondents	*Final % of respondents*
Very confident	4	28
Somewhat confident	36	61
Not confident	60	11

9. Have you had your pastures assessed for oestrogen clover levels or isoflavone levels in the clovers present?

	Initial *% of respondents*	*Final* *% of respondents*
Yes – visual assessment of pastures for oestrogenic clover level	14	40
Yes – laboratory test of clover for isoflavones	6	9
No	85	51

Final evaluation questions

10. Have you attended an event and/or heard about the MLA funded 'Good Clover Bad Clover' project run through MacKillop Farm Management Group and Agriculture KI?

Yes	60%
No	22%
Unsure	18%

	%
Attended a field day or farm walk	60
Have received a copy of the 'Good Clover Bad Clover' fact sheet/s	60
Have read about the project in the media	51
Other (please specify)	9

11. Has your exposure/involvement in the project increased your knowledge and awareness of oestrogenic clovers?

Yes	89%
No	11%

12. Please indicate how your exposure/involvement in the project increased your knowledge and awareness of oestrogenic clovers (you may choose multiple answers).

	%
Improved confidence in the identification of oestrogenic clovers	52
Increased knowledge of the impacts of oestrogenic clovers on lambing percentages	55
Increased knowledge of the assessing the potency of paddocks for oestrogenic clovers	45
Increased understanding of management options to reduce the impact of oestrogenic clovers	52%
Other (please specify)	5%

13. **Has your involvement in the project changed your management practices?**

	Responses %
Yes	54
No	46

14. **Please indicate how your involvement in the project changed your management practices. (You may choose multiple answers.)**

	Responses %
Select grazing paddocks for stock based on class of stock and/or potency rating of paddocks	74
Have undertaken measures to reduce potency of paddocks i.e. pasture renovation or drilling in other species	47
Increased ram percentage	26
Other (please specify)	11

4.7.2 Pre and post skill audits

Pre and post skill audits and evaluation were undertaken at initial field days and training days in the South East and Kangaroo Island. These field days included a presentation on oestrogenic clover and hands on paddock training exercise in the identification of oestrogenic clovers and how to undertake a risk assessment of a paddock.

Knowledge and skills

1. **What are the potential impacts that oestrogenic clover may have on ewes (tick one of the options)?** *Correct answer was all of the above.*

	Pre (responses %)	*Post (responses %)*
Difficult births	10	0
Prolapsed ewes	10	0
Decreased lambing %	7	9
Increased spread of lambing	9	8
Increased % of dry ewes	9	10
All of the above	43	74
Unsure	12	0

2. **What are the plant characteristics used to identify oestrogenic clover species (tick one of the options)?** *Correct answer was leaf markings, colour of calyx, and hairiness of runner.*

	Pre (responses %)	*Post (responses %)*
Leaf markings, colour of calyx, hairiness of runner	8	17
Stipule colour	0	7
Hairiness of leaf	0	0
All of the above	50	76
Unsure	42	0

3. **How many oestrogenic clover species are there (tick one of the options below)?** *Correct answer was 4.*

	Pre	*Post*
Three	27	23
Four	9	68
Five	0	0
Numerous	18	9
Unsure	10	0

Confidence and practices

1. **How confident are you in identifying oestrogenic clover species? Rate out of 10 with 1 being poor and 10 being very good.**

Pre skill audit: Ranged from 1-9 (average 3)

Post skill audit: Ranged from 1-10 (average 6)

2. **Do you currently use the following practices?**

Pre-skill audit:

	Normal Practice	*Sometimes*	*Rarely*	*Never*	*Not Applicable*
Conduct visual assessments of clover species present on my property	8%	15%	15%	60%	2%
Utilise tissue tests for oestrogen levels of clover within paddocks		2%		96%	2%

3. **For the following practices, do you plan to make changes to your business as a result of attending this event? Please tick your response.**

Post-skill audit:

	Confirmed what I'm already doing	*Intend to implement*	*Not ready yet (need more training/advice)*	*Not needed on my property/not relevant*
Conduct visual assessment of clover species on my property	20%	59%	7%	14%
Utilise lab analysis of clover oestrogen levels in paddocks	18%	45%	14%	23%

Evaluation

1. **Please indicate your overall satisfaction with and value of the event** *(1=poor, 10=excellent).*

	Range of Scores	*Average*
Satisfaction with the event	7-10	9
Value of the event	5-10	8.5

2. **Would you recommend the event to others?**

100% responded yes.

3. **General feedback**

- Advertise, try to get more numbers involved. But I was happy with the one on one. I learnt more today than at Binnum day.
- Good to at least take out one problem with poor lambing.
- Good.
- Good to learn good clover from bad clover.
- Very interesting afternoon.

4.7.3 Pre and post evaluation whole project core producers

1. **Has your involvement in the project increased your knowledge and awareness of oestrogenic clovers?**

100% of respondents indicated yes.

2. **Have you identified oestrogenic clovers on your property?**

100% of respondents indicated yes.

3. **How confident are you in identifying the different oestrogenic clovers:?**

	Initial *% of respondents*	*Final* *% of respondents*
Very confident	10	42 (64) *
Somewhat confident	40	42 (32)
Not confident	50	15 (0.5)

*Confidence rating for identification of Dinninup & Yarloop only.

Note: Level of different varieties identified in paddocks varied significantly with Dinninup being present on all properties, and the dominant variety on 80% of the core farms. Yarloop was the dominant variety on the other farms. Whilst Dwalganup was present on 72% of the properties it was a lot lower level in most pastures inspected.

4. **Management changes that have been implemented on your property as a result of being involved in the project:**
    - **Select grazing paddocks for stock based on class of stock and/or potency rating of paddocks (91% of respondents)**

- Graze younger ewes on safer pastures, potent paddocks retained for terminal lambs or older ewes (multiple respondents).
- Have grazed maiden ewes on identified safer pasture last year and achieved a higher scanning % and lambing percentage improvement by 10% in 2019 on KI.
- Graze cattle and terminal lambs on high oestrogenic pastures.
- Better understanding of the level of oestrogenic cultivars in the pastures and which paddocks have a higher risk.
- Now aware of which paddocks when grass cleaned should be only used by sale lambs.
- Carrying more wethers than ewes for grazing higher oestrogenic paddocks.

5. **Measures undertaken to reduce potency of paddocks i.e. pasture renovation or drilling in other species (55% of respondents)**
   - Sow ryegrass mixes into the moderate oestrogenic paddocks to dilute oestrogen uptake.
   - Use cropping program to reduce seed set of bad clovers prior to renovation with low oestrogen cultivars.
   - Now identified which paddocks to renovate.
   - Trialled new Messina clover on salt land as an alternative clover on saltland. If successful will provide an alternative clover for use on salt land and more paddocks with low oestrogen.
   - Sowing ryegrass mixtures as an alternative to crop and cut for hay to reduce bad clover seed set prior to renovation of pasture.
   - Have clay spread a paddock this year in preparation for cropping and renovation with new low oestrogen cultivars.
   - Implemented red legged earth mite control to produce more biomass and extended growth in low oestrogen pastures.

6. **Increased ram percentage** (**36% of respondents)**
   - Purchasing new genetic source of rams with plainer body, higher fertility, higher growth rate and fat for survival.
   - Have reduced ram percentage to 2%.
   - Have increased ram percentage to 4%.
   - Higher fertility Highlander genetics being trialled to improve ewe fertility.

7. **Other (45% of respondents)**
   - Avoid cutting silage in high oestrogenic paddocks
   - Recent years Yarloop has become less dominant in renovated paddocks
   - Re mating scanned dry ewes after scanning to increase lamb %
   - Trialling the use of Regulin on a group of ewes to increase lambing %
   - Now more aware that their other cultivars particularly Dinninup that cause ewe infertility (previously Yarloop was known to)
   - Investigated an old age group of ewes through abattoir to confirm uterine lesions/damage caused by bad clover
   - FDF producer assisted local producers with oestrogenic clover assessments on their properties in 2019

8. **Management changes planned to be implemented in the future as a result of being involved in the project**
    - Select grazing paddocks for stock based on class of stock and/or potency rating of paddocks (100% of respondents)
        - All respondents have indicated that graze their younger ewes on the least or low oestrogenic pastures. As more paddocks are renovated, more ewes will be able to be grazed on low oestrogen pastures.
        - All indicated that they will continue to monitor pasture composition in the paddocks with high oestrogenic clover populations
        - Identifying low oestrogenic pastures will allow more ewe lambs retained for future breeding rather than purchase replacement breeding ewes

- **Have undertaken measures to reduce potency of paddocks i.e. pasture renovation or drilling in other species (100% of respondents)**
    - All respondents indicated that they would renovate moderate and potent pastures with a mix low oestrogen cultivars.
    - Avoid winter grass cleaning of high oestrogenic paddocks until more paddocks renovated with low oestrogenic cultivars.
    - Advice sought for recommended low oestrogenic cultivars for soil type, rainfall and location.
    - Introducing a prime lamb enterprise so increasing lambing percentage is critical and will require a large pasture renovation program to reduce bad clovers.
    - Establishment of low oestrogenic cultivars with pasture renovation will allow control of capeweed and other broadleaf weeds and increase soil nitrogen availability and pasture productivity.

- **Other (100% of respondents)**
    - All respondents indicated they would like more training in identifying bad clovers and also assistance on own farm to check local levels of oestrogenic cultivars and improve confidence levels in decision making and develop management plans further
    - There is more Dinninup in pastures than what people know, more widespread
    - More photographs of Dinninup and Dwalganup leaf characteristics at varying stages

5 Discussion

5.1 Impacts of project to industry

As a result of this project oestrogenic clover has been brought back to the attention of the sheep industry as a possible cause of infertility and health issues in flocks. A generation of farmers who were not aware of the issue are now recognising it as a potential issue. Due to the widespread media, the attention of producers has been captured nationally with the project technical advisor receiving request for assistance with the identification and management of oestrogenic clovers from producers in Victoria and NSW. The project objectives have been met and this is supported by respondents to the final survey and the information from the project activities.

Objective 1: increase the awareness of 70% of the collaborating group members on the issues encountered with oestrogenic clovers

In the final evaluation 89% of observer respondents indicated that the project had increased their knowledge and awareness of oestrogenic clovers and 74% of respondents adopted the key message of selecting grazing paddocks for stock based on class of stock and/or potency rating of paddocks (see 4.7.1). Results for the core producers indicated that 100% had increased their knowledge and skills, while 91% had adopted the key message stated above (see 4.7.3).

Objective 2: 90% of the of the core group producers adopting practices to reduce the impacts of clover disease, resulting increased in scanned lamb by 20% and marking percentage by 10% and decreasing dry ewes by 5%.

The final evaluation of core producers indicated that 91% of respondents had already adopted the key message select grazing paddocks for stock based on class of stock and/or potency rating of paddocks. 100% of respondents indicated that they would adopt the practice in time. 55% of respondents had adopted measures to reduce potency of paddocks by pasture renovation or manipulation. 100% of respondents indicated they will adopt the practice in time (see 4.7.3)

The resources available and the timeframe for the project meant that part of Objective 2 was not met. Logistically low oestrogen paddocks needed to be identified and the weaner ewe lambs allocated to graze and lamb down as two year olds on those pastures and the results recorded. One core KI producer was able to achieve the result of an increase in lambing percentage by 10% above the previous year's results through targeted grazing of low oestrogen paddocks. The result may have been more significant if he had started with ewe weaners rather than maiden ewes (see 4.7.3).

The project was able to establish that with limited time and resources a picture of the severity and extent of the presence of oestrogenic cultivars within current pastures was of concern and would significantly impact ewe fertility and lambing performance albeit on a limited sample size. Assessments undertaken on approximately 100 paddocks across the South East and Kangaroo Island found 100% of paddocks had oestrogenic cultivars present with 69% of paddocks having greater than 30% oestrogenic clovers present in the clover proportion of the paddock providing the potential to cause fertility issues in ewes. Of concern is that of these, 69% of paddocks had previously not been known to contain oestrogenic cultivars and a large proportion of those paddocks have been diluted with other species. If the producers increased the overall clover content of those pastures with the advent of a good seasonal break allowing clover plants to establish, or by increasing stocking rate, or by grass or broadleaf weed cleaning then many of these pastures would become potent and impact on ewe fertility.

These issues were highlighted at field events, in the fact sheets and during the discussion with producers and producer groups. It highlights the importance of being able to identify where ewe weaners and younger ewe groups should be grazed, which paddocks need to be renovated and which paddocks can be managed by pasture manipulation in the short to medium term. Identification of the bad clovers is a learnt skill with many producers daunted by the plethora of low oestrogen cultivars present. As more people are trained in a district (producers and advisors), discussions will become more relevant and increase the knowledge base in the district which will lead to improved decision making on farm.

Opportunities for future work: The following 9 points were sent to Mick Taylor, MLA Feedbase Manager as a preliminary for further discussion. These points have been included as all are still relevant.

1. To determine the current extent of severity and cost of clover disease on the meat and wool industry in SA and Victoria (scale to suit the required evidence level). Using objective pasture measurements and a valid grid method across districts, canvassing grower groups. Canvass pregnancy scanners to identify low and variations in conception rates in local flocks, investigate identified flocks for oestrogenic clover effects.

2. Initial training of local growers for identification, distribution and management implications of oestrogenic clovers in surveyed districts (mainly 4 bad clovers responsible).
3. Establish demonstration flocks in key districts identified through clover and pregnancy scanners' survey. Develop case studies to improve lambing percentages. Show real changes lambing in short term (2 years).
4. Confirmation of the suitability of laboratory testing as a tool to assist wool producers in identifying problem oestrogenic clover paddocks.
    a. Confirm the relationship between the visual paddock assessments with laboratory results.
5. Develop an extension package, including:
    a. Completion of the Excel based decision tree for SA & other states (to be distributed via MLA and AWI networks).
    b. Glove box guide to clover disease- quick reference guide to clover ID, decision tree, management. Develop hard copy & web-based format.
    c. Guidelines for renovation of oestrogenic pasture- preparation, cultivars, seeding, and post sowing management (n*ote: will consult with UWA as this may be a milestone for them*).
    d. On-line technical support fact sheets & links (UWA seeking support for new sub clover identification booklet).
    e. Modules for oestrogenic clover areas, for integration into MLA and AWI programs, Lifetime Ewe Management, Realising Performance Potential, & Lifting Lamb Survival (MLA).
6. Train LTEM and Lambs Alive deliverers, livestock advisors, agronomists, veterinarians and veterinary/agriculture undergraduates in new add on modules and local oestrogenic clover issues and management.
7. In paddock test: Review the literature for opportunities for the development of an in-paddock test for oestrogenic clover presence in pastures and level of toxicity. Provide recommendations to MLA on the opportunities or otherwise for further research (our understanding is that UWA may be looking at this).
8. Determine the current extent, severity and cost of clover disease on the sheep meat and wool industry.
9. Investigate the potential development of a Sulfonyl urea resistant/tolerant Trikkala (non-oestrogenic, no PBR) cultivar which can be used to renovate oestrogenic pastures and allow minimal soil disturbance and effective weed control of susceptible species including storksbill, soursob and other broadleaf weeds, including oestrogenic sub clover cultivars. Similar technology to development of Sulfonyl urea tolerant medic cultivar Angel developed by SARDI funded by GRDC. This will be a game changer for high oestrogenic cultivar reduction and pasture renovation.

This project trained a Certified Seed Inspector in the SE and a commercial Agronomist on KI in identification of bad clovers and risk assessment of paddocks. These professionals were able to learn the skills to a high level of competency and 100% repeatability with one-on-one training over a very short time. A Sustainable Ag Consultant also undertook training but to retain competency (in identification and paddock assessments) more training was required. Producers also showed their ability with one of the FDF participants being regularly called upon by other producers in the district to go on farm and identify problematic clovers for other producers.

This project has supported the need for further work on oestrogenic clover with The University of Western Australia leading additional work supported by MLA. Dr Kevin Foster provided additional technical support at field events in the SE and KI, including provision of clover sampling kits for isoflavone levels. Further collaboration included regular discussions with project team members and project team member David Woodard was engaged to develop a field tour visiting Parawa and

Lochaber Agricultural Bureaus in South Australia and Best Wool and Best Lamb Groups at Apsley, Ararat and Cavendish in Victoria in October 2018.

Collaboration with Lisa Miller of Southern Farming Systems in Victoria included assistance with the bad cultivars present in pastures in SA and Victoria, as well as provision of photographs and assistance with identification of clovers for their own photographs for their new pasture publication.

Through the articles in the MLA Feedback and the MLA approved article in AWI's Beyond the Bale, the project was exposed to a wider audience and enquiries were received from producers in Western Australia, Booborowie in the Mid North of SA, Koppio on the Lower Eyre Peninsula in SA, Aspley and Wangaratta in Victoria and Sydney and Bookham in New South Wales. Producers forwarded photographs of clovers for identification and assistance with discussion on ewe fertility.

The project has been considered to be highly successful with the results achieved in such a short time. The project components in hindsight were too ambitious given the resources and time available to conduct those components.

6 Conclusions/recommendations

6.1 Conclusion

The issue of oestrogenic clovers in the South East of South Australia and Kangaroo Island is far greater than initially estimated at the commencement of this project. Assessments undertaken across South Australia before the commencement of this project estimated oestrogenic clovers to be present in approximately 30% of paddocks. The assessment of approximately 100 paddocks across the South East and Kangaroo Island found oestrogenic clover present in 100% of the paddocks with 69% having the potential to cause fertility issues in ewes. This supports the need for further work across these regions and the need for further investigation and extension in other regions in South Australia and across other sub clover areas across Australia.

This project has demonstrated that whilst producers willingly undertake visual identification of problem species, they will not conduct a detailed risk assessment of the paddock using the stick method back on their own property. This is because the assessment of paddocks is something they find complex and time consuming. Management plans were easier for producers to strategise, with support from the technical advisor. This highlights that relying on the average producer to undertake risk assessments of their paddocks and properties is not a viable strategy in managing oestrogenic clover. Greater success for the industry may be to devise a simpler method of assessing paddocks, or training livestock advisors or agronomists to undertake paddock risk assessments.

6.2 Recommendations

Following the conclusion of this project it is recommended that further work be undertaken to assess the extent of the issue of oestrogenic clovers in the sub clover areas of South Australia. In regions where oestrogenic clovers were not planted, there is the potential for them to have established with the sale and use of uncertified seed amongst producers. There is a strong likelihood that many producers and advisors are unaware that oestrogenic clovers may be a potential issue in their region and lack the skills to identify problem clovers.

Further work is required to devise a simple method of assessing the risk individual paddocks may pose or an accurate, calibrated and simple lab test that does not need to be supported by a detailed visual assessment of a paddock.

Additional issues were raised in the undertaking of this project which were outside the project's scope and objectives, providing further opportunity for work on oestrogenic clover in the future. These included the following:

- Anecdotal evidence that cows prolapsing may be linked to grazing oestrogenic clovers. Current literature suggest that it is safe to graze cattle on oestrogenic pastures, but this may now need to be revised.
- Some anecdotal information that sheep can be bred to be genetically more resistant to the effects of oestrogenic clover, and over time producers can select reproductively non-performing ewes and breed a resilient flock needs to be investigated as fact or fiction.
- Current literature and knowledge deems pasture safe once it has senesced. Some analysis undertaken by others suggests this may not been the case and seasonal conditions may play a role in this.
- Hybrid clovers have developed over time that have moderate levels of isoflavones present, how widespread these crossbreds and the variation in isoflavone levels are needs to be investigated.
- Soil fertility impacts on formononetin levels with low phosphorus, nitrogen and sulphur levels increasing the oestrogen potency. The impact of trace elements is still unknown. Applying phosphorus above maintenance levels will not lower formononetin levels below critical values for high oestrogen cultivars.
- Cold temperatures and waterlogging (an issue on KI and SE in "normal years") can also increase oestrogen levels.

This project provided an initial awareness raising opportunity in two sub clover districts of South Australia. Awareness raising is only the first step in the practice change continuum. The 9 point plan in 5.1 highlights the next steps to achieving practice change. Only a limited number of producers have now been alerted that the oestrogenic clovers are at significant levels in pastures and this work needs to be ongoing. Future R&D needs to target what options producers have to address the issue.

The industry has highlighted that more lambs at weaning is a major profit driver and that many producers have accepted low lambing percentages as their achievable target. Oestrogenic clover is one of many factors that affect lambing performance, however it's an issue that has largely been forgotten by the industry.

7 Appendix

7.1 Fact sheets

7.1.1 Managing oestrogenic clovers

Good clover, bad clover

Why manage oestrogenic pastures for sheep

Sheep grazing pastures containing oestrogenic subterranean clover can be affected by a number of reproductive disorders which together form 'clover disease' in particularly in ewes. The main oestrogenic ('bad') subterranean clover cultivars of concern are Dinninup, Dwalganup, Yarloop and Geraldton. Simply these cultivars have substances in their leaves at a higher concentration than other cultivars that have an effect on sheep similar to that of natural oestrogens. The isoflavone formononetin is the most active of these substances and clover cultivars which have high amounts are known as oestrogenic clovers.

Levels of isoflavones are potent to sheep while the leaf material is still green, as the leaf senesces the isoflavones are broken down and so grazing dry pasture has reduced risk. However if very good clover hay is made from the oestrogenic clovers and the leaf material is cured very well and has kept its colour, such hay can still be oestrogenic.

Clover disease affects ewes and wethers. Symptoms include: lowered ewe fertility, increased difficult births, prolapse of the uterus, udder development in maiden ewes and wethers, and enlarged bulbo-urethral glands and urethral blockages in wethers.

Introduction

This fact sheet has been developed as part of a MLA funded Producer Demonstration Site (PDS) project, coordinated by the Mackillop Farm Management Group and in partnership with Agriculture KI.

The project aims to increase producer awareness of the issues encountered with oestrogenic clovers, develop skills in 'bad' clover ID and implement strategies to overcome issues. Focus sites will be established in the SE and on KI.

Further details are available from Tiffany Bennett
E: tiffany.bennett@sa.gov.au

Background

Some older sub clover varieties can cause infertility in sheep and low lambing percentages. These varieties were well regarded pasture plants and widely sown in Australia from the 1930's up until the late 1960's. Although not planted for many years, like all subclovers they produce a percentage of hard seed that results in carryover and regeneration following cropping rotations

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1 Good clover, bad clover

Good clover, bad clover

Lowered ewe fertility

Ewe fertility the most important factor for flock productivity is reduced when ewes graze moderate to high levels of oestrogens in the pasture. The effect can be permanent or temporary in the flock.

Permanent infertility occurs when ewes graze oestrogenic pastures for two or three years. Older ewes tend to have higher fertility rates on normal pasture but the cumulative effect on oestrogenic pastures results in much lower fertility than younger ewes. Reflecting the time of exposure to the oestrogens in the pastures. Transport of sperm through the reproductive tract is severely restricted, producing poor conception rates and or a spread of lambing time within the flock. Once exposed to two or three years of high oestrogens if the flock is moved to non oestrogenic pastures the fertility remain affected to that degree.

Temporary infertility can occur where ewes graze germinating or green oestrogenic clover at mating or six weeks before mating. Lowered ovulation rates, poor sperm transport and a reduction in the number of ewes that mate may be the result. Summer rains at mating or spring mating on green clover increases the chance of temporary infertility.

Difficult births

A higher than normal incidence of difficult births occurs in a flock affected by oestrogenic pasture. Ewes can show minimal efforts to deliver their lambs and often may require assistance to lamb. The prolonged births often produce lambs born dead or weak from the process. Foetuses can also decompose or mummify resulting in the death of the ewe. The uterus can also prolapse and protrude from ewes at lambing or several weeks later. This often results in the humane destruction of the ewe and loss of the lamb.

Udder development in dry sheep

The oestrogenic nature of the clover stimulates mammary development and milk secretion in non-pregnant ewes and wethers. The condition has no known harmful effects, but does provide a guide as to the potency of the oestrogens in the pasture.

Enlarged bulbourethral glands in wethers

Attached to the urethra of male sheep the bulbourethral gland can become cystic and enlarged in wethers grazing oestrogenic pastures. Badly affected animals can die. Urethral blockages can also be problem more so on very clover dominant pastures.

Identifying the 'Bad' clovers

The main oestrogenic subterranean clover cultivars ('bad' clovers) are Dinninup, Dwalganup, Yarloop and Geraldton. They all have distinctive features and the 'Good clover Bad clover—clover ID' fact sheet highlights these features.

Identification of subterranean clovers is simplified by assessing three sections of the plants, the leaf markings, and the hairiness of the runner and the colour of the flower calyx.

Good clover, bad clover

Assessing the 'potency' of paddocks

Regardless of what might have been sown recently, the varietal mix of clovers in pastures changes greatly due to the influence of grazing, crop rotations and seasonal conditions. Early maturing types can build up relative to other varieties in years with a dry spring. A variety with low palatability will be favoured by grazing.

Once oestrogenic cultivars have been identified the next step is to determine how potent the pasture may be to sheep. This will vary with the botanical composition of the pasture across the paddock. Other good cultivars low in oestrogen and other pasture grasses and broadleaf's will collectively dilute the amount of oestrogens that the sheep will consume.

Paddocks can be assessed by one of two methods—visually by the 'Stick method' or by collecting clover samples and sending them for laboratory analysis of oestrogen levels. Both methods are described below.

***Stick Method*:** Using a stick of approximately 40 cms in length, walk a transect across a paddock, throwing the stick at random intervals. Record what plant is touching each end of the stick e.g. clover, grass or broadleaf. Also record whether the clover is a 'bad' clover or not. Repeat this 50 times.

From this calculate the percentage clover and percentage bad clover. If the bad clovers comprise more than 20% of the pasture record the paddock as potent.

***Laboratory test*:** walk a transect taking random selections of clover plants at ground or grazing level. Roughly chop the collected sample & subsample out a large handful overall & place in labeled paper bag. Freeze if accumulating samples or if it is late in the week. Post in paper bags so samples dry rather than sweat in plastic.
Post samples to: Southern Scientific Services, PO Box 234, Hamilton Vic 3300.

Flock management on ranked pasture

There is no cure for permanently infertile ewes caused by clover disease, so with careful management the highly potent pastures must be avoided. The aim is to keep the youngest ewes (ewe weaners) on the lowest oestrogen ranked paddocks as long as possible while the clover is green. Higher ranked paddocks may be able to be utilized once the pasture has senesced. The safest pastures should be reserved for ewe hoggets and maiden ewes. The mid aged breeding ewes on the next safest and so on. The plan is not to graze potent pastures until late in the ewe's reproductive life.

The higher oestrogen ranked paddocks should be kept for older breeding ewes, cattle, wethers or cropped. These higher ranked paddocks could be also targeted for pasture renovation with more suitable low oestrogen cultivars of clover. An assessment of the ranked paddocks and that of the sheep enterprise and business goals will determine overall management strategy.

Examine overall ewe management as a number of factors can attribute to poor lambing performance. These include inadequate nutrition of ewes at mating, poor ram fertility, over feeding in late pregnancy, and other general health problems which can overshadow the effects of grazing oestrogenic pastures.

Clover disease affected ewes can have an intermittent fertility, dry ewes can often lamb in subsequent years.

Whilst it is believed that cattle are generally not affected, further research needs to be undertaken.

Yarloop clover—leaf , stipule & flower

Source: Ramsey Seed Inc., California

Good clover, bad clover

Key tips to improve fertility

- ⇒ Do not graze young ewes on pastures that have a high oestrogenic clovers
- ⇒ Paddocks with less than 20% clover are likely to be safe
- ⇒ Delay joining ewes until at least six weeks after the clover has died & ensure ewes are in condition score 3
- ⇒ Test pasture hay for oestrogens, and if levels are high avoid feeding to ewes
- ⇒ Check ram health pre-joining and aim for 3% rams at joining
- ⇒ Consider culling adult ewes scanned not pregnant as they are likely to be permanently infertile
- ⇒ Consider drilling in winter feed to 'dilute' the clover and/or don't grass clean highly oestrogenic pastures

Source: Colin Trengove

Further Information

For further details contact: David Woodard - 0417 803 525

Fact Sheet compiled by David Woodard, Ian McFarland & Tiffany Bennett of PIRSA Rural Solutions

Renovation of pastures

The aim is to reduce the percentage of oestrogenic cultivars and replace with low oestrogenic cultivars with improved productivity benefits. Select cultivars suitable to the soil type, rainfall and required tolerances, disease resistance and targeted growth habit.

Dominant clover pastures often have a very large seed reserve in the soil ranging from 300kg/ha to 500 kg/ha of seed. In highly oestrogenic clover pastures these seed reserves need to be strategically reduced in order to allow a seeding rate of new clover at 10 kg/ha to 20 kg/ha to dominate over the existing cultivars. Reducing seed set in the years prior to renovation is a key step by cropping or cutting hay. Maximise the number of clover kills pre-seeding of the crop by encouraging existing seed to germinate.

In the year of pasture reseeding, maximize clover kill and ensure adequate soil nutrition, weed and insect control prior to and after pasture seeding. The aim is to achieve maximum seed set of good healthy seed of the preferred cultivars. A light grazing may assist runner and seed potential prior to closing up for seed development.

Seek further advice from your local agronomist.

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7.1.2 Oestrogenic clover identification

Source: Ramsey Seed Inc., California

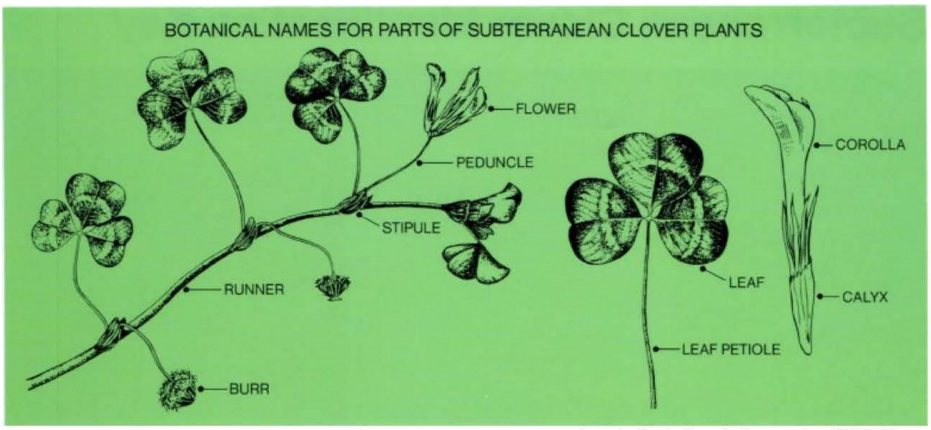
Good clover, bad clover—identification

Identifying the 'bad' clovers

The Bad clovers which are highly oestrogenic are Dinninup, Dwalganup, Yarloop and Geraldton. When these clovers make up 20 percent of the pasture eaten by ewes 'clover disease' or ewe fertility problems could occur.

To identify these cultivars three parts of the plant need to be examined the **leaf markings**, the **hairiness of the runner** (not the leaf stalk) and the **colour of the calyx** below the petals in the flower. The leaf markings can be subtle but distinctive ranging from bands across the leaflet, a central light green spot with paler or white side flecks, or white side flecks, or just a plain leaflet without these markings.

Examine a number of leaves on the one plant to ensure the leaf markings are identified correctly. Markings can vary with growth stage and conditions affect brightness and also other secondary markings. The hairiness of the runner (not the leaf stalk) can be either hairy or not hairy. Hold the runner up to the light to view the fine hairs which vary from sparse to very hairy, both



Source: Registered cultivars of subterranean clover,(1996) DAFWA

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1 Good clover, bad clover - identification

Good clover, bad clover—identification

classified as hairy.

Different cultivars can have completely hairless runners. The calyx colour can either be green or red. Different growing conditions could see the red become light purple.

Other features help distinguish these bad clovers from the good clovers including leaf marking brown outlines, distinct mid rib, leaflet colour and shape, presence of small black flecks and subtleties of the leaf markings.

Dinninup

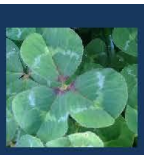
Leaf markings are green band and sometimes under good conditions with subtle pale side flecks. Young leaves often have a vivid arrowhead leaf marking with a brown outline. Band varies in colour with good fertility.

Dinninup—Hairy Runner and Purple Calyx

The runner is hairy and the calyx is often purple to red. (Leaf markings often confusing with Woogenellup (low oestrogens), but the runner is hairless and the calyx is green).

Relatively new cultivar Bindoon (low oestrogens), is virtually in distinguishable from Dinninup as it has similar leaf markings, a hairy runner and purple to red calyx. Avoid sowing Bindoon if Dinninup is already present in the pasture.

Dinninup – with pale side flecks and green band



Good clover, bad clover

Dwalganup

Dwalganup is distinguished by a central green spot and angled down white side flecks on the leaf marking, hairy runner and green calyx.

Early season cultivar so has large runner to leaflet ratio, i.e. more runner to less leaf compared to later types. Leaflets are characteristically more blue-green colour and slightly more hairy. Side on - some leaflets have a

Note side flecks on older larger leaf have faded, also presence of black flecking on some leaflets and wave curl in leaflet shape in central lower right in the photo – subtle but distinctive.

Dwalganup – blue - green leaflet colour

Green calyx is shown in the photo below

Good clover, bad clover

Yarloop

Yarloop is the easiest oestrogenic clover to identify. Leaf markings when fresh are white side flecks on pale green leaflet. The runner is hairless and the calyx is green.

Very distinguished more triangular shaped leaflets with either no side arms or white side arms. Yarloop like Geraldton has leaflets which stand apart with a wider gap between them. Leaflets may also have brown midrib.

Yarloop – note space between leaflet

Geraldton

Geraldton has a central thin green band across the leaflet, has hairy runners and a purple to red calyx

Very distinguished more triangular leaflet similar to Yarloop shape. Leaflets stand apart. As an early season cultivar it has a large runner to leaflet ratio compared to later cultivars, so looks more stems than leaf.

Geraldton – thin green band, leaflets separated, note very hairy runners

Further Information

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Fact Sheet compiled by David Woodard, Ian McFarland & Tiffany Bennett of PIRSA Rural Solutions.

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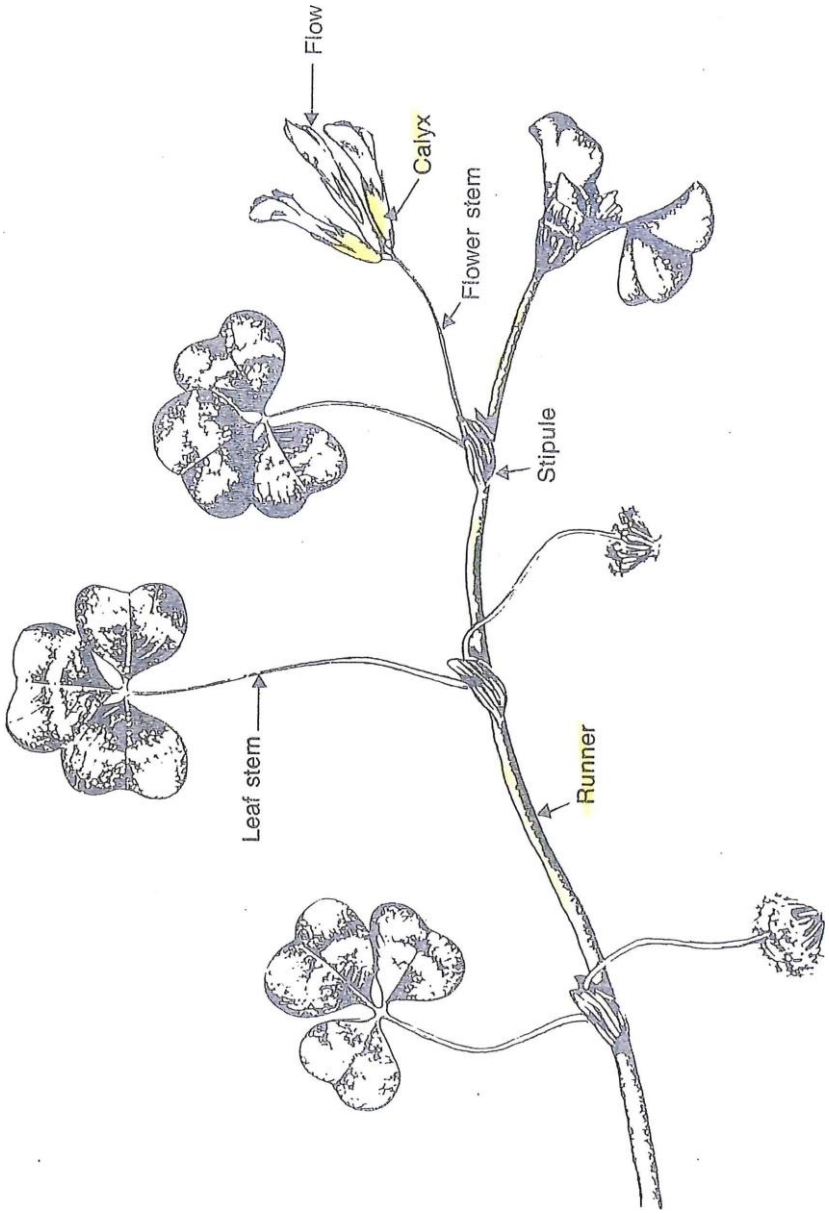
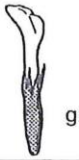
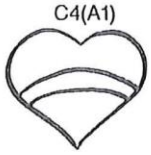
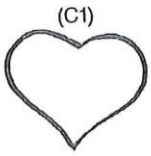
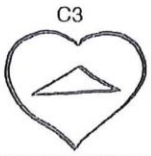
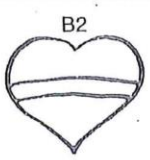
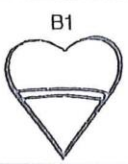
7.1.3 Sub clover identification



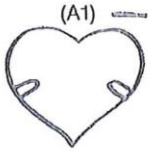
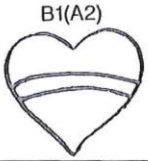
Department of Agriculture, South Australia, 1981

7.1.4 Sub clover identification chart (hairy runners)

Sub clover	Calyx colour	Leaf marking	Time of flowering	Other features
Seaton Park	 green	 C3A2	Early September	Large central spot on leaf and prominent white arms that are not angled down.
Bacchus Marsh	 green	 C3B2	Mid-September	Stipule always green.
Dwalganup (oestrogenic)	 green	 C2A1	Mid-August	Very hairy leaf surface and runner. May have pink tip on calyx. Leaf dark green.
Dinninup (oestrogenic)	 red	 C4(A1)	Early September	Leaf marking vivid. Young leaf often has a vivid arrowhead marking outlined in brown.
Daliak or Esperance	 red	 (C1)	Daliak: late August Esperance: early September	Often has a very small pale-green central spot on leaf.
Mt Barker	 red	 C3	Late September	Leaf mark does not reach the edge. Young leaves often do not have arrowhead marking.
Nungarin	 red	 B2	Early to mid-August	Leaf marking is broader than that of Geraldton.
Geraldton (oestrogenic)	 red	 B1	Mid-to late August	Leaf hairy and wedge-shaped. Leaf marking is thin. Three leaflets stand apart.

Department of Agriculture, South Australia, 1981

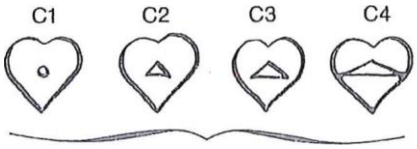
7.1.5 Sub clover identification chart (hairless runners)

Sub clover	Calyx colour	Leaf marking	Time of flowering	Other features
Yarloop (oestrogenic)	 green	 (A1)	Early September	Leaf often has no markings. Common in wet areas. Often brown along midrib of leaf. White seed.
Trikkala	 green	 C2A1	Early September	Occasionally brown under leaf marking. Common in wet areas. White seed.
Woogenellup	 green	 B1(A2)	Mid-September	Sometimes inconspicuous leaf markings.
Clare	 green	 C3A2/A3	Mid-September	Often brown below leaf markings. Occasionally hairy runners.

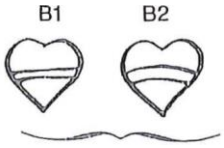
Brackets, for example (Al), indicate marking may be present.

Leaf markings

Light-green markings

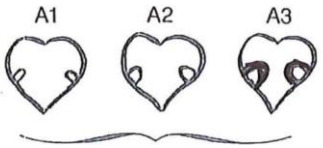


central spots



bands

White markings



arms

7.1.6 Main Oestrogenic Sub clover cultivars

Dinninup

Young leaf often has a vivid arrowhead leaf marking with a brown outline. Band varies in colour with good fertility. Hairy runner with purple to red calyx. (Often confusing with Woogenellup, hairless runner but green calyx)

Dinninup Woogenellup

Dwalganup

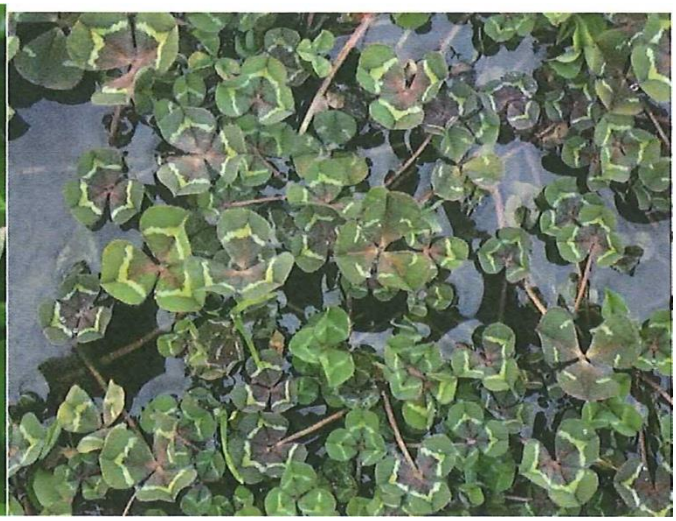
Early season cultivar so has large runner to leaflet ratio, i.e. more runner less leaf to later types. Leaflets are Blue-green colour and slightly hairier. Side on, some leaflets have a slight wave in the top. Hairy runners and green calyx with some have slight pink tip.

Dwalganup- blue green colour, wave in leaflet Trikkala- similar markings, lighter green leaflet

Yarloop

Very distinguished more triangular shaped leaflets with either no side arms or white side arms. Leaflets stand apart. May have brown midrib of the leaflet. Hairless runner and green calyx.

Yarloop- note space between leaflet



Yarloop and Trikkala in waterlogging situation, note dark markings

Geraldton

Very distinguished more triangular leaflet with thin green band (Bl). Leaflets stand apart. As an early season cultivar it has a large runner to leaflet ratio compared to later cultivars. Hairy runners with red calyx.

Geraldton- thin green band, leaflets separated

Howard, Tallarook, Meteora and Eden Valley strain

Cultivars not widely sown but are oestrogenic.

7.2 Visual paddock assessments

7.2.1 Stick method

1. Use pad, pencil and double pointed stick about 0.5m long
2. Record paddock name. Start at corner of paddock and walk diagonally across it, throwing stick every 10 paces. A minimum of 50 throws will give 100 readings. Paddocks may vary with land type so could record each area separately. 100 readings makes the calculations easier.
3. Each end of the stick is a sample number
4. At each point of the stick record 2 observations; firstly plant type (clover, grass or other broadleaf, record as tick in either column (B),(C) or (D) of table); secondly at each point identify the nearest clover (record in variety of clover column E)

SAMPLE NO (A)	GRASS (B)	BROADLEAF (C)	CLOVER (D)	VARIETY OF CLOVER (E)
1	✓			Mt Barker
2		✓		Dinninup
3			✓	Yarloop
4	✓			Yarloop
5		✓		Dinninup
6		✓		Mt Barker
TOTAL = 6	**2**	**3**	**1**	

5. Calculation for pasture composition: Add up Columns (A), (B), (C) (D) as in above table.
    a Calculate proportion of grass, broadleaf and clover in the pasture: Divide column (B), (C), and (D) by the total number of samples (A).
        i For example, total number of samples (A) = 6
            1 **% Grass** = B/A or 2/6 = 33%
            2 **% Broadleaf** = C/A or 3/6 = 50%
            3 **% Clover** = D/A or 1/6 = 17%
            4 TOTAL = 100%
            5 The pasture contains 33% grasses, 50% broadleaf and 17% clover
6. Calculation for each clover percentage: Add up the number of times each clover cultivar occurs in column (E)
    a Mt Barker = 2
    b Dinninup = 2
    c Yarloop = 2
        i Divide each cultivar total by the total number of samples taken in the paddock (A)
            1 Mt Barker = 2/6 = 33%
            2 Dinninup = 2/6 = 33%
            3 Yarloop = 2/6 = 33%
            4 The clover proportion of the pastures is 33% Mt Barker, 33% Dinninup 33% Yarloop
7. Calculation of the oestrogenic percent in the pasture
    a The percent clover in the pasture is 17%

b The percent of Oestrogenic clover is 66% (i.e. in this case Dinninup and Yarloop are both oestrogenic, so are added together)

i % Oestrogenic = (17 X 66)/100 = 11.2%

8. Paddock ranking:
   a Percent oestrogens in the paddock:
      i **0 – 20 % safe**
      ii **20 – 40 % moderate**
      iii **40 – 100% potent**
9. Rank each paddock

PADDOCK NAME	AREA (HA)	PERCENT OESTROGENS IN PASTURE	RANKING
DAM pdk	20	11.2	SAFE

7.3 Case studies

7.3.1 Fry Family, Frances, South East South Australia

Property owner:	Fry Family Farms Tim and Chris Fry & families
Property name:	'East Ridings'
Location:	Frances, South East of SA
Annual rainfall:	550 mm
Property size:	Total – 1,660 ha; 3 blocks
Enterprises:	1,600 Merino ewes & 2,600 crossbred ewes Cropping (cereals, legumes, canola & small seeds crops dryland and also irrigation) and cattle (41 breeders)
Pasture type:	Mix of annual (sub Clovers, naturalised clovers, balansa and ryegrass, barley, silver, & brome grass, capeweed, geranium) and perennials (lucerne & phalaris)
Soil type:	Sandy loam over clay, deep sand (some areas clayed) and loamy soils over clay

Introduction

The 'Good clover bad clover' project has been focused on increasing producer awareness of the issues encountered with oestrogenic clovers, developing skills in 'bad' clover identification and implement strategies to overcome issues.

'East Ridings' was one the Subsidiary Demonstration Farms established in the South East as another source of discussion on the prevalence of oestrogenic clovers in pastures with local producers.

The severity and extent of oestrogenic sub clovers in pastures in the South East of SA is largely unknown, although they can be found readily in older pastures and pastures that have been poorly renovated. The presence of a well-established pasture seed industry in the region ensures that producers have access to the most recent cultivars and technical support. The level of oestrogenic sub clovers found in the limited number of surveyed paddocks is of concern and potentially more of a problem if botanical composition of the pastures changes.

'East Ridings' background

The property has mixed enterprises of grazing, cropping and pasture seed production. Sheep grazing with a focus on prime lamb production and a small cattle herd make up the grazing enterprises. Extensive claying of the sandy soils and the fertilizer program has built up the soil fertility to enable the pastures to be highly productive,

Figure 1: Chris Fry, Fry Family Farms

Current management

Merino ewes are purchased from considered non-oestrogenic northern flocks. These are mated to Border Leicester rams to produce first cross ewes which are retained to produce terminal lambs. The flock population is 1,000 Merino ewes and 2,600 first cross ewes. These are mated in December and January for 8 weeks with an average condition score of Merinos CS 3.5 and crossbreds CS 4.5, with 2% rams for a May/June lambing.

Ewes are scanned in March and the dry ewes separated and mated again. Single and twin bearing ewes are identified and are separated into lambing groups in April. In 2018 the Merinos had 14% dry ewes and crossbreds had 8% dry ewes. The Merino ewe flock had 64% single bearing and 36% twin bearing ewes, and the crossbred ewe flock had 27% single and 73% twin bearing ewes.

Ewes lamb in May/June, in mob sizes to match paddock size at a stocking rate of 6.4 to 6.7 dse per hectare. Average lambing percentage (of the ewes present at lambing) for 2018 included Merino singles at 93%, Merino twins at 156% (proportional average is 116%), crossbred singles at 99% and crossbred twins at 166% (proportional average is 148%). These figures have not been adjusted for the number of ewes present at mating.

The issue

Lambing performance indicate that ewe fertility is at a productive level with no evidence of the effects of an oestrogenic clover issue. The slightly elevated proportion of 14% ‘drys’ in the merino flock could be due to a number of reasons.

A visual assessment[1] of 8 paddocks (in 2019) on 'East Ridings' out of 19 paddocks available, found 1 paddock with a moderate oestrogen level score[2] (Table 1). Whilst all of the remaining 7 paddocks scored had evidence of oestrogenic clovers, the overall pasture oestrogenic score was low. The concern is that 5 paddocks out of the 8 surveyed (62%) had oestrogenic clover content ranging from 34% to 89%. The proportion of grass and broadleaf weed content in the pastures had however diluted the effect of the oestrogenic clovers. A reduction in grass and broadleaf weed content would change the ranking score on 6 paddocks (75%). Only 2 paddocks would always be safe for young ewes if botanical composition of the pastures changed.

The solution

Identify which paddocks have a higher percentage of oestrogenic clover and rank them in priority and then a management plan can be developed.

Management will involve a combination of sheep and grazing management and pasture renovation.

- Pregnancy scanning.
- Be aware of pasture composition, particularly if the grass and broadleaf weed components are reduced.
- Continue grazing pastures with a low ranking in the same pattern.
- Graze ewe weaners or younger ewes on the low oestrogen based pastures.
- Continue to monitor clover composition of pastures (visually or by laboratory analysis).
- Renovate high oestrogenic clover pastures with low oestrogen cultivars.

Lessons learnt

- Better understanding of the level of oestrogenic cultivars in the pastures and which paddocks have a higher risk. The levels of oestrogenic cultivar Dinninup are much higher than was previously known and now of concern.
- Now aware of which paddocks when grass cleaned should be only used by sale lambs.
- Use more balansa and low oestrogen sub clover cultivars when renovating pastures.
- Careful management to reduce 'bad' clover population, to sow when moisture available for good plant establishment, which may mean sowing later and careful grazing to ensure a good seed set of sown clovers in the renovation year.

[1] Paddocks can be assessed by one of two method- visually by the 'stick method' or by collecting clover samples and sending them for laboratory analysis of oestrogen levels. Further details on these techniques are available on the MacKillop Farm Management Group website.

[2] Pastures with more than 20% oestrogenic clover are regarded as potent (i.e. moderate to high oestrogen level score).

Table 1: Paddock assessment results (2019)

Paddock	Grass %	Weed %	Clover %	Oestrogenic Clover %	Clover Cultivar %	Pasture Oestrogen Score
Learmount 2*	41	43	16	76	Dinninup 72 Dwalganup 4 Woogenellup 14 Seaton Park 1 Mt Barker 6	12 - Low
Warburton 2	35	14	51	34	Dinninup 34 Trikkala 27 Woogenellup 22 Balansa 7 Mt Barker 8 Seaton Park 1 Daliak 1	17 - Low
Warburton 1	69	5	26	24	Dinninup 22 Dwalganup 2 Lucerne 37 Seaton Park 7 Woogenellup 3 Enfield 2	6 – Very Low
Learmount 4	30	28	42	39	Dinninup 39 Trikkala 54 Seaton Park 3 Woogenellup 3 Mt Barker 1	16 - Low
Abels 2	50	22	28	89	Dinninup 89 Trikkala 6 Cluster 3 Seaton Park 2	25 - Moderate

Abels 3	22	33	45	14	Dinninup 14 Trikkala 83 Balansa 3	6 –Very Low
Abels 4	42	33	25	72	Dinninup 72 Trikkala 22 Mt Barker 3 Seaton Park 3	18 - Low
Deans 1 (2017)	17	0	83	4	Dwalganup 4 Trikkala 80 Gosse 8 Seaton Park 4 Woogenellup 4	4 Low

7.3.2 Simon Veitch, Kangaroo Island, South Australia

Property name:	*Karinga*
Location:	MacGillivray, Kangaroo Island
Annual rainfall:	500 mm
Property size:	Total – 1,380 ha; sheep run on 335 ha (home block)
Enterprises:	1,600 Merino ewes & 1,000 wethers Cropping (cereals, legumes & canola) and cattle (190 breeders) on two other blocks
Pasture type:	Mix of annual (sub clovers, naturalised clovers, balansa and barley , silver, & brome grass, capeweed, geranium , burr medic) and perennials (Puccinellia, phalaris & minor patches strawberry clover with annual species)
Soil type:	Sandy loam over clay, lateritic sandy loam over clay & saline soil

Introduction

Whilst oestrogenic clovers (clover disease) historically caused dramatic reductions in lambing percentages on Kangaroo Island (i.e. < 40% lambing was common), evidence from recent investigations suggests that this is not the case any longer. There is no doubt however, that many properties on KI are experiencing below expected lambing percentage.

'Karinga' background

Cattle were traditionally run on the property. Sheep were introduced when Simon returned to the property about 12 years ago.

Figure 1: Simon Veitch, Karinga

Current management

Adult ewes are mated in mixed aged mobs (at random) with 1% +1 rams, whilst maiden ewes are mated as one age group with 2% + 1 ram. Ewes are not scanned post mating.

Ewes lamb in May/June, in mob sizes of 300. Average lambing percentage for the last three years is 94%, with significant variations across the years (2016 – 83.5%; 2017 - 103%; 2018 = 95%).

Ewes are assessed for wet and dry at marking (Note: 13% dry adult ewes & 16% dry maiden ewes at marking in 2018). Adult dry ewes are culled, whilst maidens are given a second chance.

Mobs are boxed (500-600) post marking and then increased to 1,000 at weaning.

The issue

Lambing percentages vary greatly across years on 'Karinga'. Whilst an average for Merinos of 94% is ok, it is not meeting potential. The high number of dry ewes (in 2018) indicates a problem.

A visual assessment of 13 paddocks (in 2018) on 'Karinga' found 8 paddocks with moderate to high oestrogen level scores. Whilst all of the remaining paddocks scored had evidence of oestrogenic clovers, the overall pasture oestrogenic score was low. This was generally the result of higher levels of grasses present. A reduction in grass content could change the ranking score of these paddocks.

The solution

Identify which paddocks have a higher percentage of oestrogenic clover. Develop a property management plan that includes grazing management and strategies to reduce oestrogenic clovers on the property.

Key management activities will include:

- Pregnancy scanning

- Increasing ram percentage
- Continue grazing pastures with a low oestrogen ranking in the same pattern.
- Avoid grazing ewe weaners or younger ewes on the potent or moderate ranked pastures
- Continue to monitor clover composition of pastures (visually or by laboratory analysis).
- Be aware of pasture composition, particularly if the grass component is compromised.
- Renovate the potent ranked pastures with 'good' clover cultivars and ryegrass mixtures.

Figure 2: A group of producers inspects paddocks for clover in the South East of South Australia

7.3.3 Richard Kirkland – Furner, South East, South Australia

Property name:	*Kirkland*
Location:	Furner, SE
Annual rainfall:	600 mm
Property size:	2,000 hectares
Enterprises:	8,400 Merino/BL, Composite and White Suffolk and Poll Dorset crossbreds 700 ha crop (beans, wheat & canola)
Pasture type:	Mix of annual (Sub clover, Balansa clover, Arrowleaf clover, naturalized clovers, medics, Persian clover, ryegrass, silver grass, brome grass, barley grass, capeweed, chickweed) and perennials (phalaris & ryegrass)
Soil type:	Red loam, black clay, sandy loam over clay

'Kirkland' background

Historically (1980/90s) 'Kirkland' ran predominantly a Merino wether flock on pastures dominated with Yarloop sub clover. Clover disease was evidenced by bulbo-urethral gland issues in the Merino wether flock. Paddocks were set stocked. Lambing percentages ranged from 70% to 90%.

Cropping was introduced in the late 1990s and has increased steadily to current levels. Over the last 5-6 years pastures have been oversown with ryegrass and low oestrogen cultivars. Despite renovation, oestrogenic clovers (i.e. Yarloop, Dinninup and Dwalganup) are still present across the pasture paddocks, albeit at varying levels of composition.

Current management

Over time there has been a move from straight Merino ewes to Merino/Border Leicester cross ewes, with the focus now on developing a composite flock.

Ewes are mated in age groups, with young ewes mated to White Suffolk and composites (Perendale/Coopworth/ Romney Marsh), 3-5 year old ewes mated to composites, and older ewes (up to 8 years old) mated to Poll Dorsets. A ram percentage of 2.5% for all classes of ewes is used with rams remaining with ewe mobs for 5 to 6 weeks. Ewe lambs are mated for up to 7 weeks in late February/March for a spring lambing.

Ewes are scanned for single, twin or dry status and drafted on the results. Percent dry ewes at scanning (2017) ranged from 5.7 to 13.2%.

Figure 1: Richard Kirkland, 'Kirkland'

Ewes lamb in June/July with a target stocking rate at lambing of 6.2 ewes per hectare. Lambing ewes are set stocked. Mob size is increased prior to lamb marking to 700 – 800 ewes per mob. Post lamb marking, adjacent mobs are boxed together and rotationally grazed around their paddocks. Average lambing percentage for the last three years is 125%, with minor variations across the years (2016 - 125%; 2017 - 120%; 2018 = 130%).

Following weaning, ewes are boxed together further into mobs of up to 1,000 ewes

Phosphorus levels in paddocks are adequate (low P can increase oestrogen level) with paddocks being fertilized annually with either Single super @ 120kg/ha or MAP+ Zn @ 100kg/ha.

The issue

Whilst oestrogenic clovers (clover disease) historically caused dramatic reductions in lambing percentages in some areas (e.g. Kangaroo Island < 40% lambing was common), evidence from recent investigations suggests that this is not generally the case any longer. The actual impact of oestrogenic clovers across the affected areas however has not been determined.

Historically, clover disease was evidenced by the bulbo-urethral issues in wethers on 'Kirkland'. Whilst on first appearance 'Kirkland' appears to be achieving a reasonable lambing percentage, is that really the case? The 2017 lambing percentage was down 5% on average. Scanning also revealed 6-13% dry ewes across the mobs. The high level of dry ewes was suspected to be caused by silage fed at mating. A laboratory test on the silage revealed 6,280 mg/kg of phyto-oestrogens. (A level of > 1,000mg/kg is regarded as potent).

A visual assessment[3] of 20 paddocks (in 2018) on 'Kirkland' found seven paddocks with a moderate to high oestrogen level score[4] (Table 1). Whilst all of the remaining paddocks scored had evidence of oestrogenic clovers (1-24%), the overall pasture oestrogenic score was low. This was the result of higher levels of grasses, Balansa and/or Trikkala clover. A reduction in any of these species could change the ranking score of a paddock.

"Having an awareness of the issue of clover disease is important to ensure ewe fertility is not impacted. Ranking of pastures for oestrogens has allowed the development of a grazing management strategy to ensure production is minimally impacted" -Richard Kirkland, February 2019

The solution

Identify which paddocks have a higher percentage of oestrogenic clover and rank them in priority and then a management plan can be developed.

Management will involve a combination of grazing management and pasture renovation including:

- Continue grazing pastures with a low ranking in the same pattern.
- Avoid grazing ewe weaners or younger ewes on the potent or moderate ranked pastures
- Continue to monitor clover composition of pastures (visually or by laboratory analysis).
- Be aware of pasture composition, particularly if the grass component is compromised.
- Renovate the potent ranked pastures with 'good' clover cultivars and ryegrass mixtures.
- Be aware silage and hay harvested from potent pastures may also be potent.

[3] Paddocks can be assessed by one of two methods— visually by the 'stick method' or by collecting clover samples and sending them for laboratory analysis of oestrogen levels. Further details on these techniques are available on the MacKillop Farm management group website.

[4] Pastures with more than 20% oestrogenic clover are regarded as potent (i.e. moderate to high oestrogen level score).

Table 1: Paddock assessment results (2018)

Paddock	Grass%	Weed %	Clover %	Oestrogenic clover %	Clover Cultivar %	Pasture Oestrogen Score	Ranking
1	20	2	78	74	Yarloop - 71 Dinninup - 3 Shaftal - 19 Balansa - 5 Trikkala - 2	58	Potent
2	18	2	80	62	Yarloop - 57 Dinninup - 5 Trikkala - 37 Antas - 1	50	Potent
3	3	17	80	41	Yarloop - 32 Dinninup - 9 Trikkala - 54 Woogenellup – 5	33	Moderate
4	6	0	94	28		26	Moderate
5	13	10	77	32	Yarloop - 25 Dinninup - 7 Riverina - 42 Balansa - 9 Mt Barker - 8 Trikkala - 2 Shaftal - 2 Woogenellup - 2 Antas - 1 Medic - 1 Seaton Park - 1	25	Moderate

6 Strip planted balansa/ ryegrass	19	3	78	30	Yarloop - 27 Dinninup - 3 Balansa - 43 Riverina - 23 Trikkala - 2 Woogenellup - 1 Shaftal - 1	23	Moderate High/moderate in winter whilst Balansa is establishing
7	24	2	74	29	Yarloop - 26 Dinninup - 3 Trikkala - 71	22	Moderate

Figure 2: Producers are upskilled in clover identification in the South East of South Australia

7.3.4 Keith Bolto, Kangaroo Island, South Australia

Property owner:	Bolto Partners
Property name:	*Redlands*
Location:	MacGillivray, KI
Annual rainfall:	500 mm
Property size:	1,750 hectares
Enterprises:	17,500 Merinos
Pasture type:	Mix of annual (sub clover, balansa clover, naturalised clovers, silver grass, brome grass, barley grass, capeweed) and perennials (phalaris & ryegrass)
Soil type:	Sandy loam over clay, lateritic sandy loam over clay

Current management

Keith Bolto and his family have a self-replacing Merino flock and normally run around 5,500 Merino breeding ewes and 4,000 wethers.

Joining is for six weeks during February / March for a July drop, utilising 1.5% rams in mobs of 1,000 ewes. Ewes are rotationally grazed and lambed in mobs of 500. Average stocking rate is 13 DSE/ha. High performance ewes are scanned to singles and twins, but no scanning occurs in the commercial flock.

Crutching occurs in January along with the shearing of culls, which are sold in January or February. The main shearing is in April. The predominance of annual pastures on Kangaroo Island often causes a distinct break in the wool in autumn. The move to an autumn shearing has resulted in higher tensile strength.

The issue

Lambing percentages have been trending down over the last fifteen years. Average lambing percentages over the last five years range from 72% to 88% (note this includes 1700 maiden ewes out of the total of 5,500 ewes). Adult ewes lambing percentages range from 85 to 91%.

Over the last fifteen years, stocking rates have increased. During this time the Bolto family have also increased soil fertility through clay spreading non-wetting sands and increasing fertiliser applications to build soil phosphorus levels. All these activities have favored sub clovers and the prevalence of Dinninup has increased throughout the pastures. In addition, the Boltos have purchased more land that had Dinninup dominant pastures.

A detailed visual paddock survey of 30% of land area was completed in 2018. Fifteen of the eighteen paddocks inspected had a high oestrogen score and five paddocks were ranked as potent.

Preg testing some mobs and further investigations with the local Kangaroo Island vets have confirmed that poor lambing percentage is being driven by poor conception rates and not low lamb survival.

The Solution

Significant challenges exist for the Boltos given the extent of oestrogenic clovers in their pastures. They have changed the structure of the Merino wool flock, running more wethers and thus income is less dependent on lambing percentages.

Strategies include:

- Continue to identify which paddocks have a higher percentage of oestrogenic clover, rank them in priority and develop management plans.
- Graze younger ewes on the pastures with the lowest oestrogen content
- Increase ram percentage
- In highly potent paddocks drill in cereals and ryegrasses to dilute bad clover impact and increase early biomass
- Renovation of pastures with low clover seed banks
- Sowing ryegrass hay crops that can handle waterlogging to reduce the seedbank of oestrogenic clovers and sowing new varieties of clover.

Keith Bolto would like to see further research to identify economic options for renovating pastures, particularly where there are large seedbanks of Dinninup clover and cropping options are limited. Cropping is not possible on much of the property due to winter waterlogging occurring on low-lying wet country presenting a challenge for working down sub clover seedbank. This is further complicated by the large seedbanks of oestrogenic clovers which can compete with new varieties sown and dilute the newer more productive clover varieties.