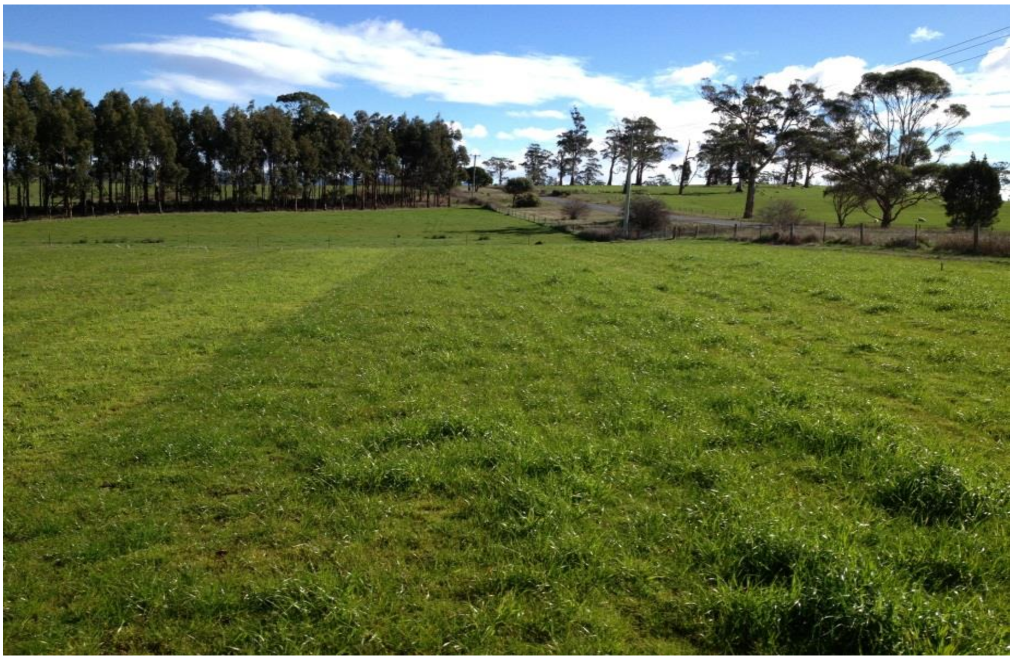
Perennial pastures renovation demonstration: turning failure into success

Final Report

June 2014



This report summarises the activity conducted by the Tasmanian Institute of Agriculture on the 'Perennial pastures renovation demonstration' at 'Greenhythe' in the Tamar Valley from 2010-14. The project was funded by Tamar NRM and the Australian Government through the Caring for Our Country Program.

TASMANIAN INSTITUTE OF AGRICULTURE
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Project Details

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Introduction

This Greenhythe site was initially established in 2010 to demonstrate the attributes of newly developed perennial pasture cultivars. It aims to assist with producer decision making and increase producer confidence in sowing alternative perennial pasture species. It was one of three in the Piper's River area that was supported by The Piper's River Neighbourhood Group which helped attract funding from Tamar NRM through the Australian Government's 'Caring for Our County' program. The lack of perennial cover in many pastures in the north-east region was one of the driving forces behind the demonstration. As the demonstration progressed, the site also became a good learning tool to learn about the challenges of renovating pastures.

The major demonstration on this site has been the evaluation of 10 perennial grass, 11 perennial and annual legume and two herb species/cultivars. As with many of the TIA Herbage Development Program's (HDP) demonstrations there has been a strong focus of the evaluation on persistence. There are a number of factors at this site that can restrict the persistence of certain pasture species including; shallow variable soil, prone to waterlogging, competitive existing grass weeds, and low fertility. Waterlogging during winter prevents sowing in early spring due to the ground conditions for machinery. It also affects plants that have low tolerance of waterlogging. In summer the site dries very quickly and the soil sets very hard. Plants that have shallow roots, restricted by waterlogging conditions during winter can find it difficult to access moisture in summer.

The demonstration was sown in a matrix design consisting of two blocks and allows a comparison of the compatibility of grasses and legumes/herbs. Frequency counts were used as an index of the persistence of sown species. The results presented here only provide a very early snapshot of which species will and will not persist long term under the conditions specific to this site.

There was also a smaller fertiliser trial sown to demonstrate the effect that the low fertility was having on the establishment of the pasture, and legumes in particular. Trace elements, lime, superphosphate and potash were applied in varying rates.

Warning: Information contained within this report relates specifically to the Greenhythe site, it's soil type and environment. What has been successful at Greenhythe may not be applicable to different soils types and environments. Conversely, what has not been successful at Greenhythe may be successful at other locations.

Event timeline

2010

The trial area was sprayed out in early spring with herbicide to remove competition particularly from weedy grasses such as browntop *Agrostis capillaris.* The site was then drilled in late September. The pasture failed due to poor legume establishment (thought to be caused by low potassium levels), damage from snails and slugs and a resurgence of browntop.

2012

Competition from browntop was identified as a major constraint on any future sowing. To address this, the area was worked in Autumn 2012 and sown with Italian ryegrass *Lolium multiflorum* and oats *Avena sativa*. Potassium was applied to redress the low potassium levels in May. The site was sprayed during winter for weed control. In early spring the Italian ryegrass and oats was sprayed out. The demonstration was then sown in early October 2012, with fertiliser being applied to the specific fertiliser trial component a week later.

2013

A decision was made to re-sow, as the Italian ryegrass fully recovered from the herbicide application to outcompete most cultivars. The best survivors were the creeping lucerne and the chicory. The site was sprayed in late summer and again in early autumn after a heavy germination of *Vulpia* sp. The site was then sown a week later in April. Slug and snail bait was applied prior to sowing. Plant and frequency counts were conducted during establishment.

2014

TIA made a commitment to continue to monitor the demonstration site for a further 12 month (until June 30 2014). In May 2014 frequency counts were carried out on the main trial area over two day and involved 3 staff members. Two counts were undertaken in every grass/legume combination plot (130 plots). Frequency counts were not undertaken on the fertiliser trial as significant areas were covered in annual ryegrass which has provided significant competition for the sown species. Publishing this data would be misleading due to the variation between plots. See **Figure 2** in the appendix for an example of the annual ryegrass.

Field day - autumn 2013

A field day was held on 28/6/2013 at the Greenhythe site (Figure 1). The day began with Rowan Smith providing a brief summary of the state of pastures in the Tamar Valley and contributing factors to pasture decline. A background to the demonstration site was provided in a field day handout. Some common weed species were identified for attendees. Stuart Smith (DPIPWE) spoke about herbicide applications for removing weedy perennial and annual grasses during the pasture renovation process. Approximately 25 Attendees had the chance to look over the establishing grasses, legumes and herbs. Rowan Smith provided background information on every cultivar in the demonstration. Large pots containing established plants were also on site so attendees had the chance to view the growth habit of the mature plant. This was particularly useful for understanding the extent of root systems, or rhizomatous and stoloniferous growth habits. Bob Reid from Tasglobal Seeds was on hand to provide information regarding their cultivars in the trial. Representatives of the other seed companies that contributed to the trial were invited but did not attend. The day concluded with a BBQ lunch and provided another opportunity for farmers and land managers to seek information from TIA and DPIPWE staff.

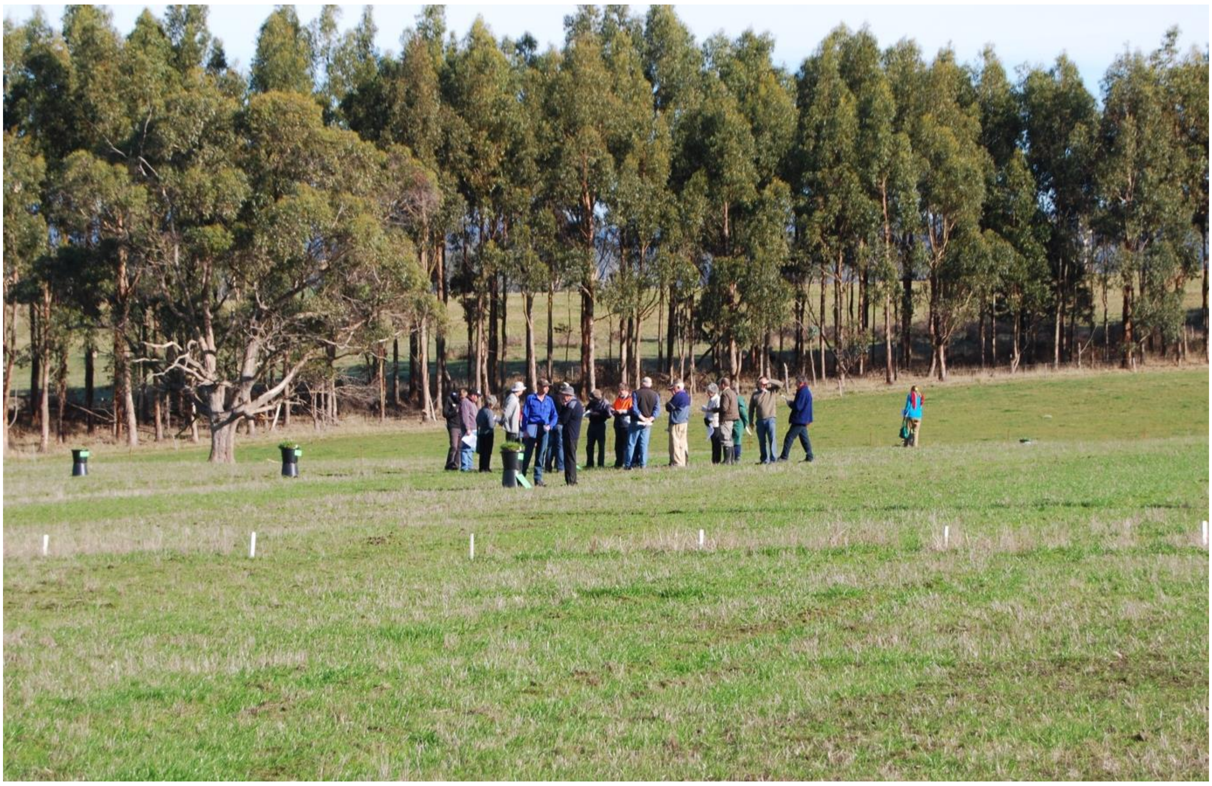

Figure 1 Field day attendees inspecting the Greenhythe site during June 2013.

Methods

Collecting an early establishment frequency score can give an indication of the number of plants that have germinated. However, it can be influenced by seeding rates and plant counts can be a better measure. It does provide a good baseline to begin to monitor the persistence of plants over time. In early establishment, scores of more than 70 are unrealistic given the size of the plants and the size of the grid, some squares can be placed in between drill rows and thus no plants will be counted. Only a series of frequency counts over time can give tangible information on persistence of individual cultivars.

Frequency method

Frequency counts are conducted using the method outlined in Quickcheck 3 in the EverGraze pasture manual. This method assesses presence or absence of the target species using a 1 m^2 grid featuring 100 10 x 10 cm squares. If a live piece of the target plant is attached to the soil in a given square then it is counted as 1, the total number of squares containing the target plant is recorded. In good established perennial pastures scores of >70% can be expected.

June 2013 assessment

Frequency counts of grasses were recorded on block 1 and are an average of 26 counts, 2 within each of the 13 legume/herb treatments. Frequency counts of the legumes/herbs were recorded on blocks 1 and 2 and are an average of 40 counts, 2 within each of the 10 grass treatments by 2 blocks.

May 2014 assessment

Frequency counts of grasses were recorded on block 1 and 2 and are an average of 52 counts, 2 within each of the 13 legume/herb treatments by 2 blocks. Frequency counts of the legumes/herbs were recorded on blocks 1 and 2 and are an average of 40 counts, 2 within each of the 10 grass treatments by 2 blocks.

Results and Discussion

In general, frequency scores (an indicator of pasture persistence) of legumes declined from June 2013 and May 2014 (**Table 1**). The exception being the Denmark[A] subterranean clover that increased from 31 to 70. This could be attributed to a large background seed bank of volunteer subterranean clover which has germinated and has been recorded as Denmark[A]. A decline in frequency following the year of sowing is to be expected for most species as plants are in competition for resources and some plants die. Lucerne and trefoil cultivars decreased to very low numbers. Lucerne does not tolerate waterlogging, preferring free draining soils, so this is an expected result. Permatas[A] Talish clover (18) and Palestine strawberry clover (18) have the highest frequency scores of the other legumes. Strawberry clover is well known to be persistent and productive in waterlogged soils (see **Figure 3** in appendix). Talish clover is very persistent in low rainfall environments and should do well during late spring and summer. It will be interesting to see how tolerant of the waterlogging it is long term. Rubitas[A] red clover established very well and produced very good amounts of dry matter during spring 2013 (see **Figure 4** in appendix). However, frequency has dropped and it will be interesting to see if the mass of spring growth returns in 2014. There was considerable variation between all plots as evidenced by the standard deviation of the means. In addition, late autumn is a time when some species have little activity and a spring frequency count may yield a different result.

Table 1 Frequency scores of legumes and herbs across all grass cultivars (mean ± standard deviation, n=40).

	Frequency Score	
Cultivar	June 2013	May 2014
Subterranean Clover (Denmark[A])	31	70 ± 21
Strawberry Clover (Palestine)	45	18 ± 13
Talish Clover (Permatas[A])	49	18 ± 17
Plantain (Tonic)	14	10 ± 9
Caucasian Clover (Kuratas[A])	32	9 ± 8
Yellow Serradella (Yellowtas)	24	6 ± 6
Red Clover (Rubitas[A])	52	5 ± 6
Chicory (Puna II[A])	13	3 ± 3
Creeping Lucerne (KI Creepa[A])	41	3 ± 4
Narrowleaf trefoil	42	2 ± 5
White Clover (Tahora[A])	24	2 ± 5
Lucerne (Sardi Grazer[A])	29	0 ± 0
Birdsfoot trefoil	35	0 ± 1

Note: A – This symbol indicates that a plant cultivar is protected under the Plant Breeders Rights Act of 1994.

Similar to the legumes, most grasses declined in frequency between the two assessments (**Table 2**). Some of this can be attributed to plant death following the first summer. The perennial ryegrass cultivars Avalon[A] and Bealey[A] had the highest frequency scores at both assessment times. The perennial ryegrass appeared to be well suited to the damp conditions and was able to establish well due to its early vigour (see **Figure 5** in appendix). The tall fescues had the next highest frequency scores and are very well adapted to the waterlogging conditions experienced over winter. The

cocksfoots and coloured brome had low frequency scores and this can be attributed to slow establishment and only fair tolerance of waterlogging. Spring sowing is likely to result in higher plant numbers for these species, although the long term survival of these species would still be questioned due to the waterlogging during winter.

Table 2 Frequency scores of grasses across all legume and herbs cultivars (mean ± standard deviation, n=52).

	Frequency Score	
Cultivar	August 2013	May 2014
Perennial Ryegrass (Avalon[A])	75	70 ± 18
Perennial Ryegrass (Bealey[A])	66	68 ± 16
Tall Fescue (Wrightsons test line)	44	42 ± 11
Tall Fescue (Quantum II[A]/Demeter)	40	39 ± 12
Winter Active Fescue (Resolute[A])	57	36 ± 14
Phalaris (Advanced AT[A])	47	36 ± 19
Phalaris (Fosterville)	37	35 ± 20
Spanish Cocksfoot (Uplands[A])	*	34 ± 13
Coloured Brome (Exceltas[A])	43	22 ± 12
Cocksfoot (Megatas[A])	*	17 ± 13

Note: *Cocksfoot cultivars were too small to count at the time of first assessment. A – This symbol indicates that a plant cultivar is protected under the Plant Breeders Rights Act of 1994.

It is interesting to look at how legume and grass species interact with each other in pastures. For instance, some grass species can have a detrimental effect on legume species in the number of plants and size of plants. It is very early to start analysing such interactions, as most pastures take 2-3 years before plants find equilibrium. In addition, the data presented is just a snapshot in time (autumn 2014). Species that are winter active at this time are likely to be larger, whereas continental species are likely to be larger in spring. An important consideration is that the means for each grass/legume combination come from just 4 counts across two blocks. However, the results presented in **Table 3** demonstrate the possibilities for analysing the data into the future if continued frequency scoring can be undertaken. High positive numbers here represent that the frequency score of the grass is positively higher than the mean for that species. For instance, the frequency of Avalon[A] perennial ryegrass is 23% higher in strawberry plots than the mean across all legume and herb plots. One interesting result is that with the exception of perennial ryegrass, Rubitas[A] red clover had a negative effect on the frequency scores of grasses. Rubitas[A] was quite vigorous during early establishment and may have depleted available nutrients for slow establishing grasses. On the flip side, Rubitas[A] had a positive effect on the perennial ryegrass counts and may demonstrate that these two species that are vigorous during establishment may be compatible. Strawberry clover displayed a similar trend. Perennial ryegrass generally had a negative effect on the frequency counts of legumes (**Table 4**). In contrast, the tall fescues had generally a positive effect on the frequency counts of legumes. As discussed, it is very early to draw any conclusions on the compatibility of grass and legumes, particularly given the large variation in soil type and susceptibility of waterlogging across the site.

Table 3 Competition effect from interactions between grass and legume combinations (% difference from the mean frequencies for the species). These scores are for grasses.

	Subterranean clover (Denmark[A])	Strawberry clover (Palestine)	Talish clover (Permatas[A])	Plantain (Tonic)	Caucasian clover (Kuratas[A])	Yellow serradella (Yellowtas)	Red Clover (Rubitas[A])	Chicory (Puna II[A])	Creeping lucerne (KI Creepa[A])	Narrowleaf trefoil	White clover (Tahora[A])	Lucerne (SARDI Grazer[A])	Birsdfoot trefoil
Perennial ryegrass (Avalon[A])	0	23	-9	-26	18	8	11	-10	8	-22	4	-2	-4
Perennial ryegrass (Bealey[A])	8	16	10	3	-9	-7	21	-6	-3	-4	-12	-11	-6
Tall fescue (PGG Wrightson test line)	5	-12	3	0	-16	0	-4	12	-6	16	-10	18	-6
Tall fescue (Quantum II[A]/Demeter)	11	-14	1	-19	2	15	-15	9	7	11	-19	-10	22
Winter active fescue (Resolute[A])	-16	-3	2	-34	47	17	-38	-10	45	-9	-11	2	8
Phalaris (Advanced AT[A])	-17	8	-1	1	26	22	-13	17	12	4	-4	-35	-21
Phalaris (Fosterville)	44	-9	-25	-17	7	-3	-32	33	6	-6	30	-23	-6
Hispanic cocksfoot (Uplands[A])	21	-33	1	-16	9	46	-26	-19	36	-36	15	16	-13
Coloured brome (Exceltas[A])	-6	-27	-40	-24	0	38	-35	29	47	-8	13	9	3
Cocksfoot (Megatas[A])	43	109	-28	-66	88	-23	-61	-47	25	-17	12	-33	-4

Compatible | Compatible | High compatibility | Low compatibility

Table 4 Competition effect from interactions between grass and legume combinations (% difference from the mean frequencies for the species). These scores are for legumes (only displayed for legumes that recorded mean frequency greater than 10.

	Perennial ryegrass (Avalon[A])	Perennial ryegrass (Bealey[A])	Tall fescue (PGG Wrightson test line)	Tall fescue (Quantum II[A]/Demeter)	Winter active fescue (Resolute[A])	Phalaris (Advanced AT[A])	Phalaris (Fosterville)	Hispanic cocksfoot (Uplands[A])	Coloured brome (Exceltas[A])	Cocksfoot (Megatas[A])
Subterranean clover (Denmark[A])	12	-3	15	-12	-3	22	-13	2	-15	-4
Strawberry clover (Palestine)	-72	-34	-6	45	18	8	-5	20	34	28
Talish clover (Permatas[A])	-68	47	1	19	32	7	27	25	-45	-45
Plantain (Tonic)	-28	-5	20	53	-38	58	-60	8	43	-50

Compatible	Compatible	High compatibility	Low compatibility

Challenges

Some challenges have been overcome during the demonstration and the lessons learnt are important to highlight to producers contemplating pasture renovation.

- Soil fertility. A key contributor to the failing of the legumes in the 2010 sowing was that potassium levels were very low. To remedy this, 100 kg/ha of potassium was applied in the form of Sulphate of potash. Undertaking soil tests prior to sowing can allow this redress of nutrient constraints prior to sowing.
- Slug and snail damage. Damage from slugs and conical snails can be a common and sometimes severe when using direct drilling techniques. This is due to stubble from the previous crop providing a good environment to live in. They can attack un-germinated seed and young plants, particularly legumes. To prevent such damage, slug and snail bait was applied prior to drilling, with follow up applications during establishment.
- Competition from Browntop. A common problem experienced when renovating a pasture is competition from species previously present in the pasture. At this site browntop was particularly competitive and one application of herbicide was not sufficient to kill it. It can take up to two years to remove browntop. Break crops like brassicas, oats or Italian ryegrass can be used between sprays to help remove weedy grasses.
- Competition from annual ryegrass. See **Figure 6** in the appendix for an example. Annual ryegrass was used as a break crop following the initial sowing to help remove the browntop. The annual ryegrass recovered after it was sprayed with herbicide prior to drilling. It is important that there is plenty of leaf area on the break crop prior to spraying. Failure to kill the annual ryegrass can leave the establishing pasture with significant competition. A check

of spray rates and sprayer calibrations prior to spraying can also reduce the chance of heartbreak later on.

Other key messages

Other important points that have been highlighted in the demonstration are;

- **Timing of sowing**. This site has posed some awkward challenges with regard to the timing of sowing. Spring is the ideal time for establishing slow establishing perennial grasses and legumes as it can result in better weed control, adequate soil moisture, increased seedling vigour and faster establishment. During spring, the site remains very wet due to waterlogging during winter meaning that early spring sowings are not achievable in a normal season. There is a short window during spring when it could be sown before moisture quickly decreases. This is when there is no rain during late spring plants can run out of soil moisture. Sowing in autumn in dryland pastures relies on the autumn break bringing rains sufficient for germination. Sowing in late autumn restricts the time plants have to establish prior to winter when growth is restricted by temperature. At this site waterlogging also become a major constraint and impacts greatly on establishment. Spring remains the best time to sow slow establishing species.
- **Space for legumes**. Producers should consider the advantages of giving the legumes their own space when establishing a pasture. This can be done by; sowing legumes prior to grasses; sowing alternate rows of legumes and grasses; or as demonstrated in this trial cross drilling the legumes with the grasses. In this case it was done by direct drilling, but can be also possible by broadcasting seed onto the surface of a worked seed bed and harrowing and rolling. These methods can be more expensive than a traditional method where the legume and grass seed goes in together, but will result in better balanced pastures. See **Figure 7** in appendix for an example.
- **Consider blends**. Some combinations of grasses and legumes simply don't work. For example, sowing a slow establishing legume with a competitive grass will result in the grass quickly out-competing the legume and becoming dominant. Demonstrations like these provide examples of combinations of grasses and legumes that do work well together and provide the grass/legume balance that the producer is after.
- **Seeding rates**. Sowing seed at rates above the recommended rate can be detrimental to the long term composition and health of a perennial pasture. Too high seeding rates can result in too many plants competing for limited resources, resulting in some plants dying and other plants becoming stunted and weak.

More information on pasture establishment can be obtained by contacting TIA.HDP@utas.edu.au

Conclusion

At this stage perennial ryegrass and tall fescue appear to be the best adapted perennial grass species for this site due to these species' ability to establish vigorously in cold and wet conditions and also withstand waterlogging. Strawberry and subterranean clover appears the best adapted legumes. Strawberry clover in particular is noted for its ability to withstand waterlogging. Talish clover has shown reasonable persistence and will be able to access deep moisture during summer due to it's massive tap root. Plantain has shown reasonable growth during spring and early summer, but was restricted by waterlogging during winter.

A significant period of time (5-10 years) is required to get quality persistence data on the cultivars being examined. This is to allow for many grazing events, and seasonal and yearly fluctuations in climatic conditions. It is hoped that an agreement can be reached with Tamar NRM in 5 years' time to revisit the site and collect persistence data. At this point, a field day could be run to show local farmers and land managers cultivars that have persisted well and remain productive after 5 years.

It is our recommendation now that the site is grazed under the normal grazing management conditions that Ed Archer implements. This can be achieved by grazing the site at the same time the remainder of the greater paddock is grazed. In the future, the gate can be closed to enable regrowth for field days or further pasture assessments.

This demonstration will be valuable in that it has shown examples of how pasture renovation can lead to failure. Low soil fertility, weeds and pests have all contributed to failures at this site. Removing these constraints prior to sowing may be time consuming and require extra effort but the return of having a persistent pasture will be of greater benefit. This site aims to assist in the decision making of producers in choosing pasture species and cultivars that are well adapted to some of the growing conditions in the Tamar Valley. These growing conditions are also common with other areas of the state. The demonstration will also add to the knowledge of the persistence of alternative grasses and legumes. The demonstration has shown the importance of using break crops to reduce weedy grass species and the importance of the timing of spray application for removing break crops.

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Appendix

Figure 2 Example of annual ryegrass in the fertiliser trial. Plants became rank and out-competed sown species during establishment.

Figure 3 Strawberry clover has adapted well to the wet winter conditions

Figure 4 Red clover was a high producing legume during spring 2013

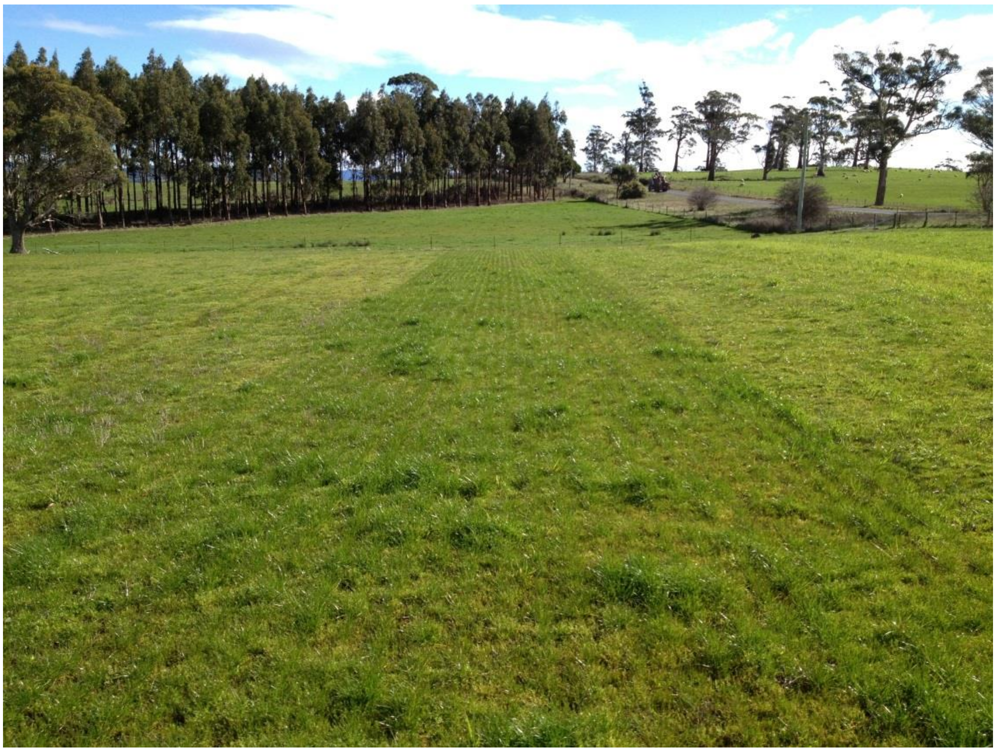

Figure 5 Early establishment vigour of perennial ryegrass (centre), compared with cocksfoot either side.

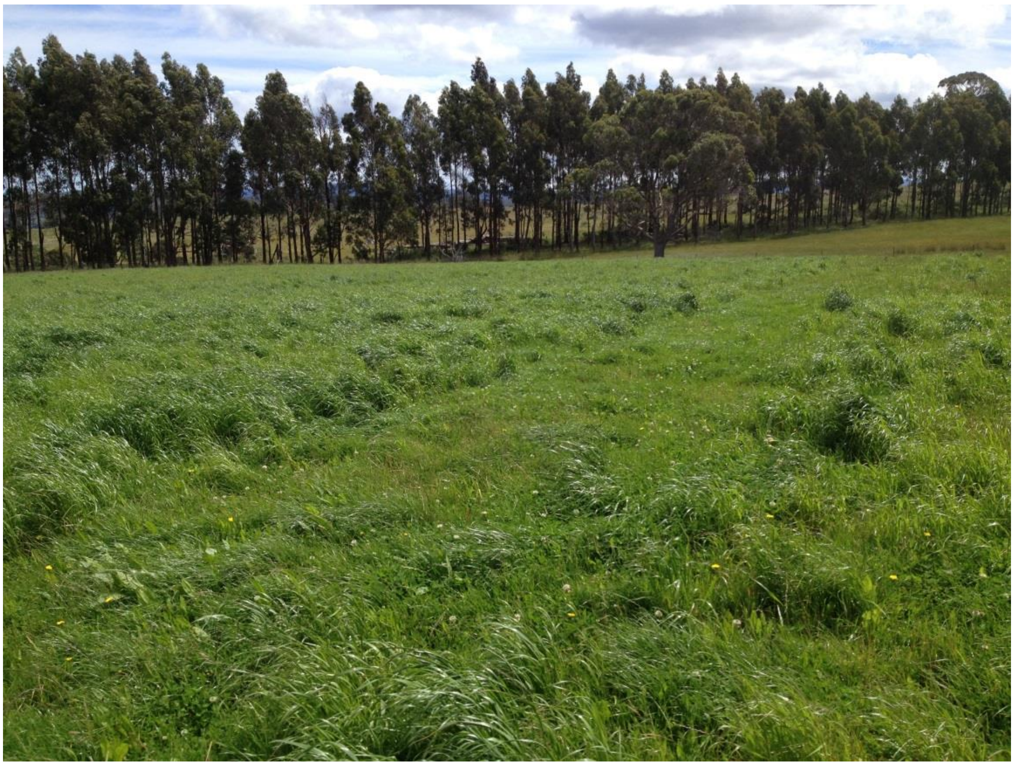

Figure 6 The clumps of taller grass is annual ryegrass which survived the herbicide application prior to sowing.

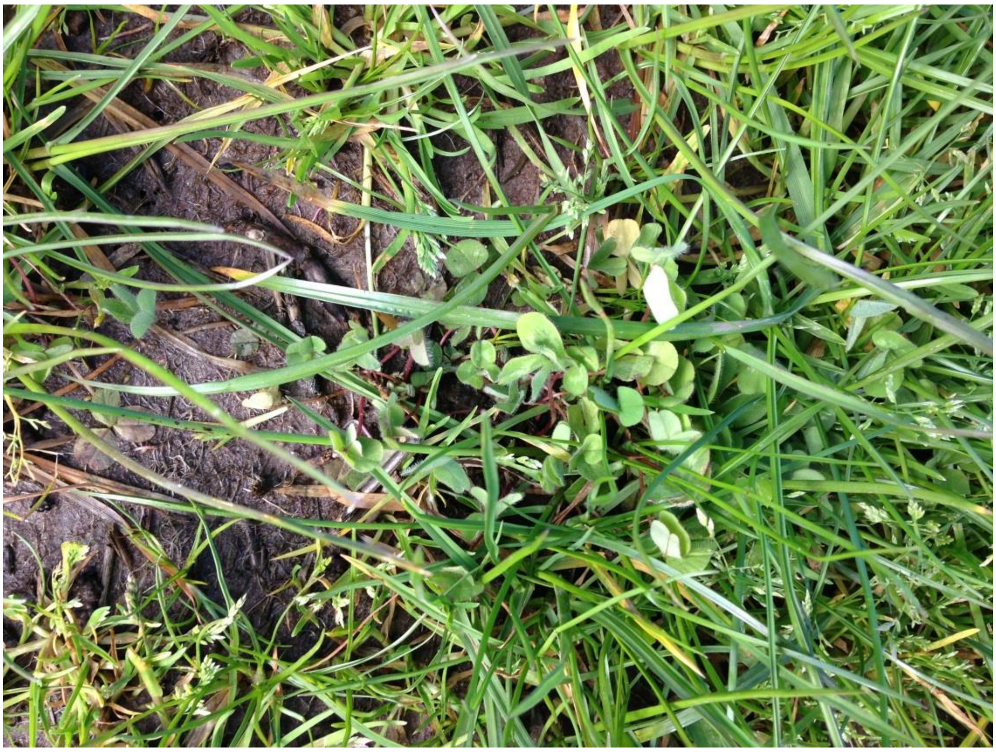

Figure 7 The importance of providing space for legumes to establish is evidenced here by red clover growing amongst vigorous perennial ryegrass.