Alternative Pasture Cropping Trial in Tasmania

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**Trial Aims**

To trial the potential implementation of direct sowing summer forage crops into a permanent pasture under Tasmanian conditions without assistance of cultivation or herbicide application. This technique was compared to the conventional sprayed off direct seeding practice & a ½ rate herbicide application.

**Background**

The trial was undertaken as part of NRM North’s Soil Condition Trial grants program. It was established on Andrew & Karyn McCarthy’s coastal property ‘Saltwood’ west of Bridport in October 2010 on the sandy coastal plains soils common in that northern coastal region. The basis of establishing the trial came from the original concept of pasture cropping farming developed by Colin Seis, a farmer in the central NSW farming region and put into practice on his farm. The selected trial paddocks have only in the last few years been developed as an improved pasture from its origins as coastal scrub vegetation. The paddocks were relatively uniform & flat with only some minor sandy rises contained within it. These coastal sands exhibit a light sandy textured soil on the high rises grading to a darker peaty, sandy soil in the hollows (photo 1). These higher rises are often more nutrient poor & prone to drying out & wind erosion. Prior to being selectively sprayed the whole paddock was grazed with fattening cattle to assist with reducing the amount of dry matter present. The aim of the grazing was to provide a more open, sparse pasture to assist with improved seed germination & plant establishment.

The pasture composition of the paddock was relatively poor with some ryegrass present 20% and a high proportion of weed infestations (80%), particularly Yorkshire fog grass (*Holcus lanatus*), sweet vernal grass (*Anthoxanthum odoratum*) & sorrel (*Acetosella vulgaris*) (see photo 2). This weedy pasture growth was also very vigorous due to the wet spring of 2010.
Site Details

The treatment strips were set up with each being approximately 25m x 150m long. Four of these strips were sprayed out with full or half spray roundup applications (17.10.2010) with the other two strips left as existing pasture (Table 1).

A soil sample was taken for the entire treatment site prior to the paddock being sprayed. Shirohie forage millet & Targa oat forage crops were direct sown in the 6 treatment plots on 15.11.2010 with a disc seeder (Photo 3). The treatment plots were then grazed over the summer / early autumn period after which the whole paddock was subsequently sprayed off to reduce the burden of the pasture weed infestations, particularly fog grass (*Holcus lanatus*). The paddock was then sown down to Winter Star annual ryegrass in the autumn and grazed over the winter/spring period within the landholder’s normal rotation. It was then subsequently sprayed

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<th>Date</th>
<th>Forage Crop</th>
<th>Herbicide Application</th>
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<tr>
<td>15.11.2010</td>
<td>Targa Oats</td>
<td>Standard herbicide spray rate (Glyphosate)</td>
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<td>- direct drilled (Oats)</td>
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<td>15.11.2010</td>
<td>Shirohie Millet</td>
<td>Standard herbicide spray application rate</td>
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<td>(Glyphosate) - direct drilled (Millet)</td>
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<td>15.11.2010</td>
<td>Shirohie Millet</td>
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<td>- direct drilled (Millet)</td>
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<td>15.11.2010</td>
<td>Shirohie Millet</td>
<td>No herbicide application – direct drilling</td>
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<td>into existing pasture (Millet)</td>
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out again, replicating the previous year's treatments and sown down on 20.12.2011 with sorghum (BMR Stature) & Rangi fodder rape variety (Table 2). The December sowing was later than planned due to the landholders other work commitments. The paddock continued to be used within the farms normal grazing rotation.

The sowing rates for each forage variety was oats 70 kg/ha, millet 18 kg/ha, sorghum 20 kg/ha and rape 4 kg/ha. Ground limestone was applied at 1.4 tonne/ha prior to the first treatment (October 2010). DAP (diammonium phosphate) at 100 kg/ha was also banded at each of the sowing intervals.

Assessments

- The pasture cropping treatments were assessed for dry matter production yields using rising plate meter (pre & post grazing) & biomass cuts of forage crops (12 x 1/4m quadrats) to calculate kg DM/ha. Biomass cuts were used across all plots where some fodder plants were too stalky to measure with the rising plate meter.
- Feed test sampling was undertaken to assess for quality of pasture feed.
- Soil carbon tests were taken prior to the trial establishment (mid October 2010) & at the end of the second treatment season (late February & November 2012).
• Soil health assessments (including aggregate stability, soil invertebrate abundance, earthworm count and soil compaction) were undertaken prior to the treatments being applied in October 2010 and March 2012.

• Frequency count of sown fodder crop seedlings were also assessed with random 12 x ¼ m quadrat counts per treatment equating to 72 quadrats in total (December 2010 & February 2012).

• Microbial testing for each treatment was undertaken in March 2012.

Results

Frequency Count

Year 1. Much higher fodder seedling frequency occurred in the full & ½ sprayed plots for oats & millet compared to the no spray plots (photo 4). This was to be expected due to the vigorous pasture growth & cover at the time in a good growing season. The no spray plots for oats & millet had 10 & 2 seedling counts respectively, (fig. 1).

Year 2. Overall seedling count was much lower than for the previous year. The sorghum ½ sprayed plot was much higher in count than the full spray plot but the plants were smaller in size (fig. 2). The no spray sorghum plot also had a number of small seedlings amongst the established pasture grasses (see photo 5). This is likely due to warm, moist conditions at the time which was conducive for sorghum vigour and some open spaces within the pasture. There was no evidence of any rape seedlings in the no spray plot.
Dry Matter Yield

Year 1. Oats & Millet Treatments

The results of the oats & millet quadrat cuts (24.1.2011) prior to grazing show a trend of increased dry matter yield for the oats treatment with less herbicide input (2010-11). This was due to the predominance of pasture weed species making up the majority of the yield with only a few small oat seedlings present in the composition. The trend for the millet was also similar (fig 3). There was also sparse ground cover between the full sprayed oat seedlings in contrast to the no spray oats. The oat treatments also showed higher overall dry matter yields than the millet. There were a number of millet seedlings present in the no spray strips but they would not have made much difference to yield due to their low frequency & small size.

Year 2: Sorghum & Rape Treatments

The results of sorghum & rape quadrat cuts (23.2.2012) prior to grazing show reduced dry matter yields for sorghum (full & ½ spray treatments) compared to the previous year’s oat treatments but higher yields overall compared to the millet (full & ½ spray). The yields for the rape plots (full & ½ spray) were also higher than for the same millet plots from the previous year & comparative for the full spray treatment to both the oats & sorghum yields, (fig 3). Lower seeding rates, poor germination or a combination of both can also have a significant effect on dry matter yields.
**Feed Quality Results**

Metabolisable Energy (ME) & crude protein in feed are important determinant factors in livestock condition & weight gain. The results show some trends between some of the treatments. The full sprayed plots over the 2 years showed the highest MJ/kg DM for all of the treatments with only the ½ spray rape equal to the full spray rape (fig 4). Sorghum had the lowest level for overall feed quality even though the plants visually looked the healthiest & most robust of all the forage crops. Rape had the highest % of crude protein across all of the 3 treatments even for the no spray plot (fig 5). This was surprising considering that there were no rape plants present in the plot. Soil fertility and/or fertiliser inputs may have played a factor in these results as well as the possibility of some remnant annual ryegrass included in the sampling from the previous season's pasture. Due to the poor pasture composition & weed infestation particularly in the non sprayed plots the figures showed a general trend of better quality feed in the sprayed out plots compared to the no spray plots, which was composed predominately of weed grasses with some remnant annual ryegrass.

![Graph of Feed Quality Results](image)

**Dry Matter Removed**

Dry matter that was removed through grazing was measured using rising plate meter pre & post grazing for the spring/summer seasons (2010-11 & 2011-12). Even though the overall dry matter yield of the ½ & non sprayed treatments was higher the amount of feed removed from these plots by grazing cattle was significantly lower than the full sprayed

![Graph of Dry Matter Removed](image)
plots (fig 6). This correlates with feed quality discussed previously, with the non sprayed plots highlighting the poor quality feed available with very low or no amount of feed removed. As an example, the ½ spray oat plot showed a negative result which suggests that very little grazing of the treatment occurred initially & that vegetative growth occurred when re-measured post grazing. Initially the ½ sprayed oat plot had good oat seedling growth but overtime weed regrowth outcompeted the young plants resulting in poor establishment.

**Carbon Results**

Total carbon testing was undertaken prior to the trial’s establishment & twice towards the completion of the trial. There appears to be no correlation between the plots that have had the same treatments and been tested at the various times in 2012 (fig. 7). For example the total carbon percentages for the full spray oats-sorghum plot decreased whereas the levels increased for the full spray millet-rape plot. Total carbon levels have increased across the board from the initial test undertaken (October 2010) with the full spray oats-sorghum (Feb 2012) & the half spray millet-rape (Oct 2012) recording the highest levels at 4.85% & 4.94% respectively. In contrast the pre trial test was only 2.31%.

This disparity between the pre & post testing results would require considerable inputs of organic matter to increase the levels to such an extent. Either the sampling pre trial was undertaken to a greater extent on the slightly higher rises with less organic matter or to a lesser extent in subsequent sampling or that the laboratory testing techniques were not rigorous enough. There may also be some soil composition variance across what appears visually to be a uniform paddock.
The practice of spraying off as replicated in the full & half spray oats - sorghum may have resulted in a period of reduced groundcover which assisted in certain levels of carbon being released from the system. But this doesn’t account for the increased level of total carbon in all of the 3 millet - rape plots (fig. 7).

The labile carbon results with the exception of the no spray oats-sorghum plot showed a fall in the overall labile carbon levels from February to November 2012 (fig. 8). This could back the argument that the reworking/spraying & establishment of a ryegrass pasture in March may have had some impact with levels of active carbon leaving the system. Seasonal changes may also be a contributing factor in these results. It’s interesting that the labile carbon levels for the no spray millet-rape plot had the highest recording (686 mg/kg) of any other plot in (February 2012) but dropped significantly to one of the lowest recordings (473 mg/kg) in November.

Increases in soil carbon normally occur relatively slowly in a pasture situation over a number of years in association with appropriate farm practices being implemented. Otherwise to increase it substantially would require large additions of organic matter.

**Aggregate Stability**

Aggregate stability refers to the ability of soil aggregates to resist disintegration when forces associated with factors such as water or wind erosion or tillage practices are applied. Aggregate stability is also affected by the percentage of soil organic matter as it plays a key role in binding the soil together but also maintaining air & water porosity. This association may be the reason why there is a correlation between the total organic carbon, labile carbon and the aggregate stability findings. The total carbon reading for February with the exception of the pre trial results and to a lesser extent the November reading had a strong correlation with the aggregate stability levels (fig 7 & 9). The labile carbon results also showed a similar trend (fig 8). Overall increased soil carbon which is also an indicator of increased soil organic matter levels shows a corresponding increase in the aggregate stability levels. This has major implications for farming practices on these sandier soils of the north east which are often low in organic matter and aggregate stability of the soils. The reason for the relatively high organic...
levels at the site may be associated with the paddocks history, which until recently was relatively undisturbed bushland resulting in a residue of soil organic matter. In relation to the treatments implemented over the two years there appears to be either little influence, or at best, mixed results on changes in carbon levels from these treatments, but that changes in total and labile carbon levels have an influence on the aggregate stability of these soils.

Soil Macrofauna

Testing for soil life involved digging a 30cm³ section of soil & identifying for the presence & number of macro invertebrates. This was undertaken initially at the beginning of the trial (October 2010) & towards the end (March 2012). This was replicated 4 times for each plot. Results showed very low presence of macro soil life across all plots and at the 2 time intervals. Only two adult earthworms were identified one in Oct 2010 & one in March 2012. There were no significant levels of other macrofauna present.

Due to the light sandy fine textured nature of the soil type, no cultivation, minimal traffic & long grazing rotations, there was very low levels of compaction observed over the time interval & no visible crusting on the surface. No sub surface hard pan was noticed as well.

Total Active Microbial Population

The total active population test is comprised of lactic acid bacteria, active fungi & cellulose utilisers, yeasts, actinomycetes & photosynthetic bacteria. The findings may indicate that some soil microbial activity may increase when in association with summer forage crops such as sorghum & millet. The ½ spray sorghum plot also had a very high number of well established sorghum plants which may relate to the high microbial count being influenced by an increased food source when the plants roots have died (fig 10). High microbial activity can also have a close association with increased soil carbon as well as aggregate stability levels but these findings do not indicate any correlation between the two.
Observations

- The normal & ½ rate applications of herbicide applications as was expected exhibited the best germination & growth rates for all of the forage crops that were sown, especially the standard spray rate. The no spray strips did show some seedling emergence particularly for the millet, sorghum & oats crops but all plants had poor growth rates due to the competition from the weed species & ryegrass present. From observations, sorghum appeared to be the most successful forage crop to become established in the no sprayed plots, likely due to the warm, wet conditions during the crucial germination phase. The rape & some millet strips in other paddocks had virtually no seed germination. The ideal pasture growth conditions during the last 2 spring periods would have also provided strong competition for any emerging seedlings in the no sprayed strips.

- One of the effects of the herbicide applied strips was the relatively scant vegetative ground cover between plants, particularly for sorghum & millet. This resulted in a number of previously absent weeds from the area becoming established such as sow thistle, nightshade & fat hen. The incorporation within any forage seed mix of clover & forbs species may be one management tool to reduce the incidence of these weeds occurring. In contrast the strips not applied with herbicide had no infestation of these weeds within the sward.

- Another observation was the high frequency of the weed toad flax in the strips where the standard herbicide rate treatments were used. The lack of plant competition, wetter winters & the possible effect on surface biota or pH at the top soil layer may have had some influence on this increase.

- Some larger clover patches also became established in the plots that had herbicide applied with much less frequency observed in the no spray plots. Less competition with other pasture based species would have influenced this result as well as the more open canopy of the forage crops allowing for increase light infiltration.

- Total carbon levels as well as active carbon to a lesser extent had a relatively close association with aggregate stability readings. But there appeared to be little or no correlation between carbon levels and the various treatments applied.
Conclusions

- Compared to the standard practice of spraying out the paddock and direct drilling, any sowing into existing pasture in Tasmania will mostly result in compromised growth of the intended crop. Some pasture species, particularly native species on mainland Australia are adapted to seasonal fluctuations by going into a semi or full dormant state and not regrowing even when conditions have improved such as out of season rains. This period can be an opportune time for growers to plant a crop when pasture competition is considerably reduced. In contrast the main pasture species in Tasmania often respond quickly to any precipitation especially during the warmer months. This factor reduces the option of direct drilling into pasture when soil moisture is ideal due to increased competition from the existing pasture.

- One possible management tool to reduce pasture competition when direct sowing into a pasture is to increase the grazing intensity on the paddock prior to sowing as this can provide an opportunity for increased forage germination with lessened competition. It was thought by the landholder & the field officer that the grazing intensity for both seasons was not high enough in assisting in the reduction of the pasture & weed competition and opening up the sward. Higher grazing intensity may have resulted in providing better forage seed germination and that crucial head start.

- Another suggested management tool is the manipulation of the disc seeder. This could be done by slightly increasing the angle of the disc (flatter angle) which would provide a wider bare seed row & so giving the seed a head start prior to weed competition increasing.

- There may be some advantage with the natural reseeding of fodder crops such as oats which naturally reseeded in some extensive swards in certain sections. Implementing some management techniques such as opening up the pasture sward through intensive grazing prior to seed shedding may assist with natural reseeding which would align closer to the pasture cropping approach. This method could also apply for other cool temperate cereal crops such as wheat & barley.

- In relation to the previous point the possibility of an autumn based pasture cropping practice as an alternative to the summer based system used in this trial, may be a consideration in the future. The use of appropriate wheat, barley or triticale varieties may have a better fit during the autumn period as some varieties are more frost tolerant and could naturally reseed similar to the oats. This may suit some landholder’s management plans.
**Disclaimer**

This trial was established as a demonstration trial and was not a fully replicated trial. Proven conclusions cannot be drawn from these results. No responsibility is accepted by Serve-Ag Pty Ltd for any loss or damaged arising in any way or form from the use of the information provided in this report.

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